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**LOSS OF POTASSIUM IN FOOD FOR PATIENTS WITH CHRONIC KIDNEY
DISEASE (CKD): A SYSTEMATIC REVIEW.**

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Loss of potassium in food for patients with Chronic Kidney Disease (CKD): A systematic review.

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Abstract

Individuals with chronic kidney disease (CKD) usually due to their treatment need to reduce the consumption of food sources of potassium or use culinary processes to reduce potassium. However, the most effective cooking methods have not been determined in the literature. Therefore, our objective was to synthesize all information about potassium loss in the various foods studied and to evaluate the most valid culinary processes for this purpose. Nine databases were searched from April to July 2017 from May to June 2018, we included all articles that reported the amount of potassium after cooking. We included 59 articles with great food heterogeneity, methods cooking, food preparation and other characteristics in evaluations. Results showed that the water cooking with heating provides potassium reduction in most studies, and in the case of vegetables, it can be done in the microwave. And we have identified that dry heat does not seem to be a suitable method for this purpose. Therefore, this systematic review suggests that water cooking promotes a greater loss of potassium, possibly due to leaching, but it is necessary to consider the domestic applicability and that more studies are needed to standardize the research in this area.

Key words: potassium, cooking, kidney disease, eating.

Introduction

Chronic kidney disease (CKD) characterized by a decline in renal function is a worldwide public health problem and in Brazil, with a high incidence, prevalence and a tendency to increase in the advanced stages (Coresh et al. 2003; Jha et al. 2013; USRDS Annual Data Report 2017; Marinho et al. 2017). Its onset may also be associated with other disease and risk factors (Marinho et al. 2017; Fox et al. 2012; Gansevoort et al. 2013; Hill et al. 2016; Mahmoodi et al. 2012). Additionally, impairment of renal function may be associated with hyperkalemia, hyponatremia, water retention among others (Helou 2004; Einhorn et al. 2009).

The purpose of CKD treatment is to allow slow progression, reduction of complications and onset of other diseases, improve survival and quality of life of these individuals (Levey, A. S.; Coresh 2012). Normally, the initiation of conservative treatment or kidney replacement therapy depends on clinical outcome (Gricia, Kusumota, and Cândido 2009; Levey, A. S.; Coresh 2012; Levey et al. 2003). In all clinical treatments, nutritional guidelines are essential and complementary in view of the need for restricted diet, for example for the control of hydroelectrolytic disorders and the need to minimize depletion of nutritional status (Santos, Abreu, and Carvalho 2003; Scheibler et al. 2010; Cano et al. 2006; Telles and Boita 2015).

Hyperkalemia is an important hydroelectrolyte disorder due to cardiac outcomes that increase the odds of mortality. In these individuals it may be associated with the stage of renal functional, the use of drugs that influence potassium excretion, simultaneous diseases that affect potassium balance and high intake of potassium source foods (Einhorn et al. 2009; Lazich and Bakris 2014).

Therefore, among the nutritional therapy recommendation for chronic kidney disease, control of potassium intake is necessary. This control can be done by reducing the consumption of food sources and using culinary processes to promote reduction in the potassium content of foods (Telles and Boita 2015; Mira et al. 2017).

As matter of facts, there are culinary procedures that can be used to avoid unnecessary food restrictions in relation to potassium content in food. One of the most used culinary processes is the double or single cooking in water that according to Cuppari et al. (2004) the single and double cooking promotes on average reduction of 59% and 20% additional potassium content in vegetables, respectively. However, the most effective cooking methods to provide loss of potassium in food have not been determined in the literature (Copetti, de Oliveira, and Kirinus 2010).

In the literature are few studies that perform evaluations of culinary processes in foods with the goal of reducing potassium focused on the renal patient and no study is found to review this content. Therefore, for best our knowledge, this is first study that carried out a systematic review of the literature on the subject and with great comprehensiveness regarding food, culinary processes and different objectives to carry out the studies (e.g. grain yield, loss and concentration of nutrients).

With this systematic review, our aim was to synthesize all possible information through extended search about potassium loss in the various foods studied and to evaluate the most valid culinary processes for this purpose and to expand the possibilities of cooking methods for reducing potassium by directing this orientation to renal patients.

Methods

Searches

The systematic review of the literature was conducted out by a comprehensive literature research from April to July 2017 with a final update in May to June 2018, in accordance with the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (*PRISMA Statement*) (Moher et al. 2009). Nine electronic databases were used: PubMed (Medline), Cochrane Library, Web of Science, Scopus, SciELO, BVS (Virtual Health Library) – LILACS (“Latin American and Caribbean Health Sciences Literature”) and Google Scholar. The searching strategy consisted of keywords by using the boolean operators “AND” and “OR” for the combination of the following search terms (in portuguese and english): potassium, cooking, culinary, soaking, reduction, removal, potassium loss, nutrient loss, renal, and kidney. We did an extended search with these keywords because we found only 9 articles in which the objective was loss potassium and/or kidney disease. Because this is a literatures review, this research exempts approval from the Research Ethics Committee.

Criteria for study inclusion or exclusion

Articles were suitable for inclusion in the review if they reported on the amount of potassium after cooking. Articles were excluded if: it was not possible to access the full text, were review articles, to evaluate the amount of potassium in preparations or meals rather than in isolated foods, do not evaluate the potassium concentration before applying the cooking methods, presented non-conventional food processing and/or food, where it was not possible to replicate it to domestic and unusual foods (e.g., germination method and food peels, respectively).

Article selection and data extraction

The search for the articles was performed by three researchers independently who selected the papers by reading the title and abstract according to eligibility criteria. All articles identified as potentially relevant by any of the researches were included at this stage. Duplicate articles were removed by a fourth researcher. Another source of research to ensure a comprehensive literature search was the search in the reference lists of the screened articles and was performed by one of the researchers.

The data for analysis were extracted by four researchers and inserted in a spreadsheet, based on the following categories: (1) study code, (2) bibliographic data (author, journal and year), (3, 4) type and scientific name of food, (5) food preparation, (6) presence of towing, (7) type of towing, (8, 9, 10, 11) number, method, medium and utensil of cooking, (12, 13) sample and water amount, (14) type of water for cooking, (15) proportion sample:water, (16, 17, 18) time and temperature cooking and post cooking method, (19, 20) amount of potassium before and after cooking, (21) percentage of reduction of potassium, (22) potassium analysis method, (23) statistical analysis, (24) sampling (duplicate, triplicate), (25) main results, (26) conclusion. During data extraction, any disagreements were resolved by consensus with two authors. Only published data were extracted, did not attempt to contact authors.

After extracting data, the foods were classified in nine groups based on the Brazilian Table of Food Composition (legumes, vegetables except tubers, roots and green, fruits and derivatives, sweets and derivatives, nuts and seeds, cereals and derivatives, meats and derivatives, fish and seafood, tubers and roots, green) (BRAZIL 2011). However, the category of sweets and derivatives was excluded, because only one evaluation with chocolate was included. Foods included in each category were shown in chart 1.

The cooking methods were categorized in cooking in water, pressure cooking, cooking in water with microwave, dry heat cooking, steam cooking, dehydration and towing. The preparations of food before cooking were grouped in non-performing, non-usual part

discarding, subdivision, discarding and subdivision and freezing and thawing. In addition, foods were categorized as to the potassium content considering raw food in below ($<100\text{mg/portion}$), medium ($101\text{-}200\text{mg/portion}$) and high ($201\text{-}300\text{mg/portion}$)(NKF 2010).

Finally, to standardize the potassium amounts before and after, we convert the units to $\text{mg}/100\text{g}$ considering that it is the most usual for the great majority of the articles to present their data with this unit of measured.

Data analysis

Descriptive statistical analysis

Firstly, Shapiro-Wilk normality test was used and the appropriate test was chosen according to distribution. We used the Wilcoxon test analysis of the before and after potassium amount considering cooking methods and food groups. The Statistical Package for Social Sciences (SPSS) software was used considering 95% confidence interval.

Simulation of data

Since that several studies do not showed the after cooking standard deviation values neither the reduction of potassium percentage, we performed a simulation of data in order to decrease the variability of the data, improving the comparison estimates through of impute the data based in the standard deviation presented in some foods belonging to the same group. After that, the difference of after minus before was performed and the delta showed in box plot graphs comparing the cooking methods by food groups. The R software was used considering 95% confidence interval.

Results

Study selection

Of the 142 articles were identified in the database and in the list of references, only 59 articles comprising 471 evaluations met the inclusion criteria and were included in this review for data extraction and analysis. The results of all the searches and the reasons for exclusions were given in Figure 1.

Study characteristics

This revision data shows the high food heterogeneity, cooking methods and food preparation among studies (Table 1). Regarding of food type, the legumes, tubers and roots had higher frequency (n=251, 53%) followed by green (n=71, 15.1%) and the method was more frequent the cooking in water (n = 312, 62.2%). As expected, 70.4% (n=332) carried out the discarded no usual parts and subdivided or did not prepare any food before cooking. Additionally, for quantitative analysis of potassium only two methods were found, atomic absorption spectrophotometry and flame photometry.

We should highlighted the huge variability in number of cooking, cooking time, cooking temperature and proportion sample:water. Unfortunately, the studies often do not report these details in methods, which limit to explore these data.

Descriptive analysis

We observed cooking in water with microwave, steam cooking, water cooking and towing showed significant potassium reduction ($p < 0.05$). On the other hand, dehydration and dry heat cooking provided did not change the after potassium concentration (Table 2).

Statistical analysis with simulation

Because of the variability of the studies or/and incomplete data in the studies (mainly de standard deviation after cooking), we performed the simulation data. Besides we although we can improve the standard deviation after cooking with simulation in general, we do not observed significant differences between cooking methods by food. However, it is still possible to make some comparisons with the simulated data.

Cooking in water in most food groups showed the greatest difference in potassium loss, such as the group of nuts and seeds, meats and derivatives, and tubers and roots in which this method will always promote potassium loss (Figure 2-F, H, B). However, cooking in water for the group of fruits and derivatives and cereals and derivatives allowed the concentration of this mineral (Figure 2-G, I).

Cooking in water with microwave for the group of green stands out for the considerable reduction of the amount of potassium (Figure 2-C). And, towing as with aqueous methods, it has also been shown for fruit and derivatives and green groups in which it seems to promote greater loss of potassium (Figure 2-G, C).

The dry heat cooking showed potassium concentration in foods, especially the group of vegetables except tubers, roots and green, nuts and seeds, meat and derivatives, and green with a higher concentration of potassium (Figure 2-E, F, H, C).

Discussion

The main contribution of this systematic review was to show that most foods reduce potassium from the application of cooking method with water and heating confirmed by a simulation data strategy. It was possible identify that the green can obtain greater loss of potassium with a method in water done in the microwave and that the content potassium in the fruits can reduce with towing. This review also demonstrated that the use of dry heat is

not a good option for the purpose of losing this mineral and that the towing in some cases does not make so much difference.

Among all these findings, another important characteristic observed is the lack of standardization to carry out these studies. For, it is known that cooking provides physicochemical and structural changes in food according to the temperature, cooking time, dilution, food preparation and other variables used may change the different sensory and nutritional properties (Alves et al. 2011; Santos, Abreu, and Carvalho 2003).

Cooking in water is possibly characterized as a good method for potassium loss, which is in agreement with some studies (Cuppari et al. 2004; Scheibler et al. 2010; Burrowes and Ramer 2008). Alves et al. (2011) demonstrated that for broccoli the water cooking with the application of various temperatures promoted a significant mean reduction of potassium of approximately 76,2% and the cooking in water and microwave approached with a significant reduction of 64,2%. Potassium leaching may reflect the ion exchanges facilitated in aqueous medium when the temperature between the food matrix and the soaking water (Picq et al. 2014).

In our analyzes, the towing in some food groups did not show satisfactory results for potassium loss, however we suggest that there may have been interference in the simulation due to the reduced number of studies included in this evaluation. In addition, we observed that the application of the towing may reduce potassium in the fruit group. However, it is necessary to perform culinary tests for the applicability of this discovery in domestic practices considering the organoleptic aspects of food (Goran et al. 2016; Marimuthu et al. 2012; True et al. 1979).

The dry heat may concentrate the amount of potassium present in food, so it is a method that should be used with caution by patients with chronic kidney disease. Probably,

this event occurs due to decreased of potassium leaching with the cooking medium according found by other studies.

For applicability of the results of this review it is necessary to take into account aspects related to food, such as consistency and appearance for better acceptability and to not lose the pleasure in food. With this in mind, we suggest that patients with chronic kidney disease who require potassium restriction in their diet, prefer the consumption of cooked foods in water, should be advised to add water before applying dry heat methods, for example in meat and prefer the cooking of vegetables in water and using the microwave. However, we caution that further studies are needed to identify better domestic applicability for this purpose to evaluate the aspects mentioned above.

The possible limitations of these findings included our decision to reach the literature that involved the inclusion of studies that did not aim at the loss of potassium, with this there was great intrinsic variability. In addition, most of the studies found did not present the standard deviation of the potassium amounts before and after the application of the method, which did not allow an exact analysis of the cooking method. Another potential limitation was the number of studies found in some methods, for example, towing, pressure and steam cooking, which had a smaller number of studies and may have interfered with the simulation.

Conclusion

This systematic review has demonstrated that cooking in water provides greater loss of potassium and specifically in green the cooking in water in the microwave seems to be better when compared to the other methods. However, the isolated application of the towing does not seem to be as advantageous in the reduction of potassium. With the lack of data it is necessary to standardize all interferences possible for the realization of the studies to allow

comparisons more suitable for this objective. This study is especially important for patients with chronic kidney disease that has implications for public health, given the high prevalence.

Additionally, it is necessary to take into account the domestic applicability of the culinary procedures considering the organoleptic characteristics to benefit the individual with chronic kidney disease. Therefore, further studies with standardized analyzes and procedures are needed to minimize the intrinsic variability of the studies and to enable better comparisons between methods.

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Declaration of interest statement

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