A REVIEW ON THE EFFECTS OF PROCESSING METHODS ON THE NUTRITIONAL COMPOSITION AND ANTINUTRITIONAL COMPONENTS OF QUINOA (*Chenopodium quinoa*) AND BUCKWHEAT (*Fagopyrum esculentum*)

Fatin Nadiah Saypol Anwar[1] and Marina Zulkifli[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan Malaysia*

**Corresponding author: marina547@uitm.edu.my*

Abstract: Quinoa originally from Andean region and buckwheat from China are two pseudocereals gradually making their way into the daily diet of humans due to its numerous health benefits. Both are packed with nutrients such as essential amino acids, proteins, fibre, vitamins and minerals. However, there is a limitation towards its use due to antinutrient components. Examples of antinutrients include phytate, saponin and tannin that affect the ability to absorb the nutrients. Thus, processing methods were executed in order to observe whether it gives positive or negative impacts towards the nutrients and antinutrients content. Processing methods reviewed include heat treatments (cooking, steaming, boiling, roasting, drying), germination and pressure. In this review, results showed that the roasting and germination process increases the content of nutrients while the process of pressure and microwave produces a lower loss of nutrients. For antinutrients, washing and boiling were the best processing technique to lower the antinutrient contents. It appears that the combination of heat and water would be the most effective way to increase the content of nutrients and lower the antinutrients in both seeds. Deeper research regarding these two pseudocereals is highly recommended, particularly in processing methods because it is proven to positively impact both nutrients and antinutrient components. For that reason, the application of quinoa and buckwheat seeds in the food industry can be expected to be industrialized over time, as they are believed to contain all the essential nutrients which can benefit one's health.

Keywords: Quinoa, buckwheat, processing methods, nutrients, antinutrients

1. Introduction

Quinoa (*Chenopodium quinoa*) is a type of seed known for its high nutritional quality comprised in its grains and leaves as stated by Martínez et al. (2015). Buckwheat *(Fagopyrum esculentum)* is also a type of seed known as pseudocereal as it generates starch seeds like cereals (Schoenlechner et al., 2008). Both of these seeds contain antinutrient components such as saponin, tannin and phytate. Filho et al. (2015) stated that if antinutrients are consumed in such large quantities, it can cause harmful effects to one's health. On the other hand, processing methods like boiling, soaking, germination and malting have been known to decrease the antinutrient components in quinoa and improve its nutrient content (Srujana, 2019). It was found that processing methods using heat application showed a great reduction. However, it has also significantly affected the protein structures which obstructs complete digestion of food proteins. Therefore, the different results on the effects of processing methods on these pseudocereals have strengthened the main objective of

this article review being conducted to observe whether it gives positive or negative impacts to the nutrients and antinutrient components of both seeds.

2. Discussion

Quinoa has been considered as a superfood for its magnificent nutrient's properties due to the high-quality protein. The nutritional components of quinoa include carbohydrates, lipids, fiber, vitamins, minerals, gluten, isoflavones, betains and carotenoids (Gordillo-Bastidas et al., 2016). For composition of nutrients in buckwheat, it consists of a higher amount of minerals than quinoa. Macroelements like K, Mg, Ca, Na and microelements such as Zn, Fe and Mn are found in high quantities for buckwheat seed. However, both seeds are known to contain antinutrients components which include saponin, tannin and phytate. Saponin, which causes bitterness to the quinoa seed, has reduced its palatability as a source of food. A study done by Galwey (1993) stated that saponin is toxic once it reaches the bloodstream. It is known to affect digestibility of protein in humans and animals by precipitating with the protein component thus forming complexes (Samtiya et al., 2020). Phytic acid is capable of binding with bivalent minerals like calcium, iron, zinc, copper, even protein and enzymes (Matilla et al., 2018). Therefore, processing methods have been conducted in an attempt to lower these components of antinutrients.

Motta et al. (2019) mentioned that after quinoa has undergone processing methods, it has shown positive impacts such as improving the digestibility, bioavailability of nutrients, taste, flavour, texture and palability of these seeds. In this paper, quinoa seed undergoes proximate analysis, cooking and drying process while buckwheat seed undergoes heat treatments, germination and high hydrostatic pressure to see the effects of processing methods to the nutrients of both seeds. For proximate composition of quinoa, the parameters include analysis of moisture, crude protein, crude fat, crude fibre, total ash and carbohydrate. From the result observed, the process of boiling, steaming and roasting of quinoa has significantly decreased most of its nutritional contents except for analysis of moisture, total dietary fibre and carbohydrate. For the processing method of cooking (boiling and steaming) to the minerals of quinoa, steaming causes a much lower loss to the minerals as it uses lower temperature. For drying, a range of temperatures from 40°C, 50°C, 60°C, 70°C and 80°C were used. Medium temperature of 60°C-70°C would be the most optimum temperature to dry the quinoa seeds as high temperatures cause a reduction in the nutritional and mineral components.

Heat treatments for buckwheat include the process of microwaving, boiling, roasting and steaming. Microwave processing methods are encouraged to be used as less nutritional loss are observed rather than the boiling and roasting process. Steaming method has shown an increase in minerals of iron (Fe) for buckwheat seeds. Next, a germination method with different time periods from 0 h up to 72 h was observed. Analysis of crude fat, reducing sugars, crude protein, ash and carbohydrate were done. The amount of crude fat, reducing sugar, protein and carbohydrate were seen to be increasing over time (Zhang et al., 2015). However, it is notable that the longer the germination time, the higher the carbohydrate loss (Lee & Kim, 2008). For high hydrostatic pressure (HHP) method, Deng et al. (2015) in his study found that it has issued the highest increased amount of histidine and alanine but recorded the lowest composition of threonine, serine and glycine. The HHP process does not bring any positive impacts or increases the amount of chemical composition (starch, protein, lipid, ash, total flavonoids and total amino acid) of buckwheat seeds. It causes the lowest reduction of nutrients. As highlighted in this review paper, processing methods that can increase nutritional value are through the process of germination and

roasting. To produce a lower loss of nutrients, HHP, microwave, steaming and boiling methods are in accordance.

Lastly, on the effects of processing methods done on quinoa and buckwheat seeds, the highest reduction of antinutrients is from the boiling process. Deng et al. (2015) found that after boiling for 30 minutes, it causes the highest reduction (35.7% and 27.6%) for tannin and saponin. Process of microwaving causes a 27.5% and 20.1% reduction while HHP caused the smallest reductions (19.9 and 4.5 %, respectively) for tannin and saponin. Comparing the non-heat method, it is observed that washing, soaking and germination are in line with its effectiveness in decreasing antinutrients. Then, comparing all four heat treatments often used to make food, boiling tops as the most optimum method to reduce antinutrients components, followed by roasting, microwaving and HHP. Both quinoa and buckwheat seeds are forecasted to continually rise up due to a few aspects. No longer seen as a trend, there is a need towards consumption of organic food and gluten-free products in the daily lives of consumers along with the addition of various innovations in producing healthy food are one of the main causes as to why consumption of quinoa and buckwheat has seen a steady yet gradual increase.

3. Conclusion

Roasting and germination are the most effective methods in increasing the nutritional value of a seed while HHP and microwave processes are the best way to lower the nutrient loss during processing. For antinutrients, washing and boiling were the most effective processing methods in lowering the antinutrient contents. Overall, heat plays a major role in reducing the amount of antinutrients as well as increasing the amount of nutritional value. However, processing methods surrounding the effects towards antinutrients of these samples are very limited. Therefore, more studies need to be conducted in order to understand how these antinutrients can be minimized, especially using the application of heat and how the application of heat itself can increase the amount of nutrients for a maximum absorption to the human body.

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