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Psuedocereals – The Grains For 21st Century Food Security

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Introduction

A pseudocereal is any plant that does not belong to the grass family but produces fruits and seeds that can be used as staple foods. They are dicotyledonous grains and are considered as an alternative to true cereals and their compositions are similar to true cereals. The most commonly consumed pseudocereals are amaranth (*Amaranthus hypochondriacus, Amaranthus caudatus* and *Amaranthus cruentus* of Amaranthceae family), buckwheat (*Fagopyrum esculentum* of Polygonaceae family) and quinoa (*Chenopodium quinoa* Chenopodiaceae family).

The amino acid profile and nutritional properties like protein content, essential amino acid index, biological value, protein efficiency ratio and nutritional index of pseudo cereals are higher compared to conventional cereals like rice, wheat and maize. The seeds are a good source of unsaturated fatty acids, dietary fiber and essential micronutrients. Phenolics present in pseudo cereals help in preventing and reducing of oxidative stress, are anti-cancerous, anti-diabetic, anti-inflammatory, anti-hypertensive and prevent cardiovascular diseases.

Pseudocereals can be used as a supplement to enrich traditional foods or in new food product development. The commercialization of pseudo cereals can help to combat life style diseases, as well as development of palatable gluten-free products for celiac persons to improve their nutrient intake.

Buckwheat shows a higher starch level due to a greater proportion of the endosperm material whereas amaranth is characterized by the highest protein content of 16.3%. The quantity and quality of the protein in pseudocereals is higher than cereals due to the availability of lysine which is limiting in cereals. Both amaranth and quinoa contained high amounts of fat

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due to high proportional size of the embryo within these seeds. In pseudocereals, unsaturated fatty acids like linolenic acid exists in higher amounts. Both amaranth and quinoa have high ash content indicative of presence of minerals required by the body.

Protein bioavailability is high as shown in several animal studies than in common cereals and close to the quality of animal proteins. The high content of arginine and histidine that are essential for infants and children growth makes amaranth and quinoa developing foods to be provide adequate nutrition to children. As per FAO/WHO, amaranth is rich in tryptophan and lysine and can be fortified with sorghum and maize-based foods. The buckwheat and wheat flour proteins differ in globulin and albumin, present in higher quantities in buckwheat but is deficient in prolamin and glutelin and vice versa. Quinoa contains essential amino acids like threonine, lysine and methionine in a balanced proportion. They contain a low concentration of prolamins making them suitable for celiac patients.

The protein score is indicative chemical score of most limiting EAA present in the sample. The greater the EAAI, the more balanced amino acid composition and the higher quality and efficiency of the protein BV estimates the nitrogen potentially retained by the human body after consumption. The PER index, which describes the ability of a protein to support the body weight increase, was higher for maize and millet flours. NI is the only one which considers both qualitative and quantitative factors and it is a global predictor of the quality of a protein source

Amaranth flour had the highest digestibility of 78.7% among all the gluten free flours. Protein quality can also be affected by processing. However, when processed under conditions that do not damage the availability of essential amino acids, protein quality of the pseudocereals seeds is not negatively affected by processing or may slightly improve due to increased digestibility. The amaranth grains when popping showed increase in total lysine content.

To provide health benefits, current dietary guidelines suggest that starchy foods should contain at least 14.0% of resistant starch on a total starch basis. Buckwheat has the highest levels of resistant starch of 27.0 – 33.5% helping in modulating blood glucose and lipid levels, regulate intestinal microbiota and help reduce obesity.

Bioactive components of pseudocereals:

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Outer layers of quinoa and amaranth contain bioactive phytochemicals like phenolic acids, flavonoids (flavonols, flavones, isoflavones, flavanones and anthocyanidins), lignans, and stilbenes. These polyphenolic components are associated with different organic acids and carbohydrates. The phenolic substances like phenolic acids, tannins, and flavonoid components are present in the seed coat of quinoa and amaranth.

Buckwheat has total phenolic content ranging from 29.0 to 1371.0 mg/100 g were as amaranth has 2.0 to 24.0 mg/100 g. Buckwheat seeds contain a type of soluble carbohydrates called fagopyritols with 269.4 – 464.7 mg/100 g which is a source of D-chiro-inositol, a compound with beneficial effects in patients with non-insulin dependent diabetes for improved glycemic control.

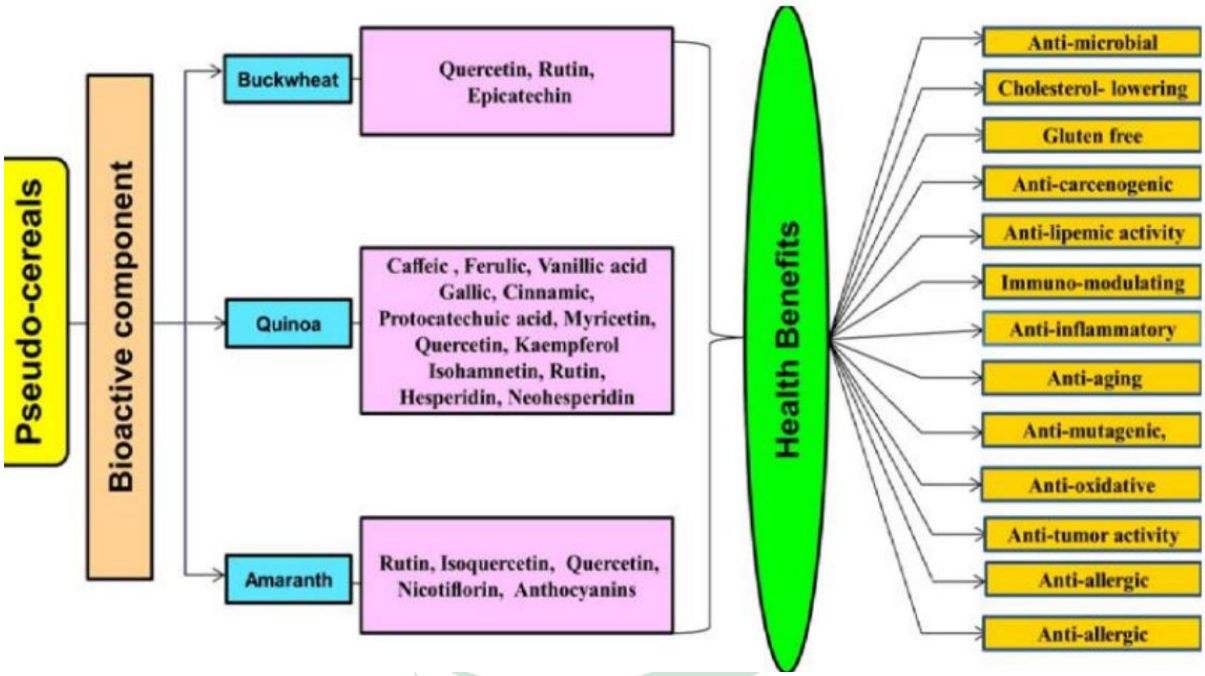

Figure 1: Bioactive components of pseudocereals and their health benefits

Bioactive peptides: BAPs are obtained from the hydrolysis of proteins that show markedly positive effects on health. They are composed of 2 to 20 amino acid residues. They have ability to regulate physiological processes, alter cellular metabolism by acting as signaling agents through hormone receptor interactions and signaling cascades causing effects locally or in various organs. The two most common methods of obtaining BAPs are enzymatic hydrolysis and microbial fermentation.

Health benefits of pseudocereals

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The common health benefits of pseudocereals like amaranth, buckwheat and quinoa include:

Hypocholesterolemic activity:

The lipid-lowering activity of buckwheat proteins is linked with their ability to stimulate the bile acid secretions. The squalene content in amaranth exerts a hypocholesterolemic effect by increasing the removal of steroids through feces. The regular consumption of quinoa in diet can decrease low-density lipoprotein (LDL) and total cholesterol.

Anti-cancer activity:

The consumption of antioxidant-rich pseudocereals can prevent the development of cancer by protecting DNA from oxidative damage. The methanolic and ethanolic extracts of buck wheat have shown the capability to defend against DNA injury caused due to hydroxyl radicals.

Antidiabetic activity:

The bioactive peptides and hydrolysates from different pseudocereal based foods have antidiabetic effects through inhibition of digestive enzymes as well as that of dipeptyl peptidase IV (DPP-IV) and reduction in the level of blood glucose. Depending on cooking time, the GI of quinoa ranges from 35.0 to 53.0. Frequent consumption of quinoa can help in the suppression of FFA, thereby improving insulin sensitivity and lower levels of blood glucose and triglycerides.

Functional properties of the gluten-free pseudocereal flours:

- Water absorption capacity reflects the amount of water that the flour can absorb and retain. For an improved food texture of bread products, higher values for water absorption are desired. Higher water absorption values were attributed to the higher content of starch and fiber content.
- The water and oil absorption capacity depends on the type of protein, amino acid composition and protein polarity and hydrophobicity.
- The degree of starch from the flour that absorbs water is expressed by the swelling power property.
- The high swelling power could be related with the higher content of amylopectin.

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- The foam capacity of a flour is dependent on the configuration of protein molecules and carbohydrates present in the flour. The flours intended for use in bakery products should present good foam capacity.
- Bulk density represents a measure of flour heaviness. The higher bulk density as lipids might act as adhesives in the aggregation of the flour particles, leading to an increase in the bulk density.
- The smaller starch granules of amaranth have a higher swelling capacity, better water-binding capacity, lesser gelatinization temperature and great resistance to amylases.
- The starch of amaranth grains has been considered to have good gelatinization characteristics as well as good thaw/freeze stability in the food industry.
- The type of proteins and the presence of non-polar side chains may have an effect on oil absorption capacity which finally affects the mouth feel and capacity to retain the flavour.