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Chapter

Introductory Chapter: Nutritive Value of Pseudocereals

Asel C. Weerasekera, Kanchana Samarasinge
and Viduranga Y. Waisundara

1. Introduction

Pseudocereals are becoming more popular in the gluten-free diet as a healthy substitute for gluten-containing grains in the modern world. The United States of America was the first country to recognize the health benefits of whole grains and embrace whole grains for the prevention of cancer and numerous cardiac diseases [1]. Grains are considered as an essential part of the human diet since the ancient time as it provides around 50% of an individual’s energy and protein requirements (Figure 1).

2. Quinoa

This plant adjusts readily to many climate zones, agroecological soil types, and is a water-efficient crop that thrives in low-moisture environments [2]. Quinoa has a higher protein content than rice, making it more nutritious and it is also considered high in sugars such as R ribose, D galactose, and maltose [1]. It also contains an exceptional ratio of amino acids that are essential. It is abundant in phytosterols, saponins, and phytoecdysteroids, all of which are helpful for the overall quality of human health [3]. Moreover, albumin and globulin make up majority of the stored proteins in quinoa. Quinoa is considered to have high levels of non-protein tryptophan, which can be rapidly absorbed and helps to boost the usefulness of that kind of amino acid in the brain, influencing serotonin neurotransmitter production. Quinoa is low in saturated fats, rich in fiber, cholesterol-free, low in sodium, lowers the probability of

Figure 1.
Health benefits of Pseudocereals.
forming kidney stones and gallbladder stones, helps digestion, and is high in anti-
oxidants. Quinoa is rich in vitamin E, vitamin C and vitamin B [4]. Quinoa contains several phytochemicals that are produced through metabolism [5]. Cooked quinoa leaves are highly nutritious and easy to digest, and these leaves are consumed in most parts of the world to obtain various health benefits [6].

3. Amaranth

Amaranth plant is generally a fast-growing dicotyledonous plant that adapts to a wide range of soil types and climatic conditions. Amaranth is classed as a nutritious Pseudocereal due to its high protein content [7]. It is thought to have originated from the United States of America in the ancient time. However, Amaranth is now produced in most parts of the world since it is regarded as a superior pseudocereal with numerous health benefits. Amaranth aids in maintaining healthy cholesterol levels, Amaranth is also low in sodium, low in fats, aids in weight loss, anticarcino-
genic and gluten free. Plant proteins found in amaranth include globulin, albumin, prolamins, and glutelin. Quinoa and Amaranth both pseudocereals are rich in folic acids. According to [6] when comparing normal cereals with pseudocereals, normal cereals contain low folic acids than pseudocereals. Amaranth is typically consumed as a popped cereal in the world and amaranth is also used as a flour to make types of pasta, bread and other food products [7]. Amaranth contains a lot of calcium and iron making it rich in nutritional values [8]. Amaranth is consumed by a number of individuals including athletes, individuals suffering from type 2 diabetes, people suffering from coeliac diseases and malnourished pupils (Figure 2).

4. Buckwheat

Buckwheat noodles and pasta are commonly consumed by people across the world at present. People consume buckwheat seeds primarily. In addition, buckwheat leaves are also consumed because of the health advantages [2]. Buckwheat, which is high in resistant starch, can help to reduce colon cancer. Buckwheat is rich in protein, several vitamins and unsaturated fats. Albumin and globulin are abundant in buckwheat [6] (Figure 3).

Due to the fiber content found in buckwheat, it has the capacity to lower blood lipid levels and to protect against chronic illnesses [9]. Some of the flavonoid compounds found in buckwheat include rutin, hyperin, procyanidin B-2, orientin, vitexin, quercetin, isovitexin, and kaempferol 1–2-0-rutinoside [9].
5. Millets

Millets are small-seeded crops of many species that are commonly produced in India to meet the production of food needed for a growing population. Millets are rich in nutrients and provide a number of health advantages. Different species of millets include Finger millet, Pearl millet, Foxtail millet, Little millet, Kodo millet and Barnyard millet. Millet is considered as a versatile grain that can be consumed in a variety of ways, including porridge, bread, beverages, and malt [10]. Millets contain significant amount of tryptophan, methionine, aromatic amino acids and cystine. Origin of millet is considered to be in Asia and in Northern Africa. Millets have the ability to reduce the risk of myocardial infarction, reduce diabetes, decrease high blood pressure, aids in maintaining healthy sleep routines, optimize kidneys, promote bone health and improve alkalinity. Millets are also gluten free and helps in relieving menstrual cramps in females.

5.1 Finger millet

Among the species of millet, Finger millet has a number of names that are used in different parts of the world (Table 1). The common finger millet is also called as *Eleusine coracana* in botanical terms [11].

5.2 Pearl millet

Around 500 million people across the world rely on pearl millet consumption and production for a living [10]. Pearl millet is a simple plant to grow compared to other grains. Pearl millet is known in the botanical name as *Pennisetum typhoides* and it also known in different names in different countries (Table 2).

<table>
<thead>
<tr>
<th>Country</th>
<th>Name/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>Ragi</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>Tailabon</td>
</tr>
<tr>
<td>Uganda</td>
<td>Bulo</td>
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<tr>
<td>Sri Lanka</td>
<td>Kurakkan</td>
</tr>
<tr>
<td>France</td>
<td>Koracan, <em>Eleusine coracana</em></td>
</tr>
<tr>
<td>Germany</td>
<td>Fingerhirse</td>
</tr>
</tbody>
</table>

Table 1. Alternative names used for finger millet by different countries across the world.
Pseudocereals

<table>
<thead>
<tr>
<th>Country</th>
<th>Name/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>Bajra, Cumbua</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>Dukhon</td>
</tr>
<tr>
<td>Germany</td>
<td>Hirse</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>Thana Meneri</td>
</tr>
<tr>
<td>Russia</td>
<td>Mogara, Morapa</td>
</tr>
<tr>
<td>Nepal</td>
<td>Kaguno</td>
</tr>
</tbody>
</table>

Table 2. Alternative names used for pearl millet by different countries across the world.

<table>
<thead>
<tr>
<th>Country</th>
<th>Name/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>Kodo, Arugu</td>
</tr>
<tr>
<td>Africa</td>
<td>African bastard millet</td>
</tr>
<tr>
<td>Pakistan</td>
<td>Mandal</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>Ammu Meneri</td>
</tr>
<tr>
<td>New Zealand</td>
<td>Dutch millet</td>
</tr>
</tbody>
</table>

Table 4. Alternative names used for little millet by different countries across the world.

5.3 Foxtail millet

The botanical term of Foxtail millet is *Setaria italica* [12]. In ancient China, Foxtail millet was widely cultivated [8]. Around the world Foxtail millet is also known in different names as follows (Table 3).

5.4 Little millet, barnyard millet and kodo millet

Group of minor millets include little millet, barnyard millet, and Kodo millet. The botanical term of little millet is known as *Panicum sumatrense* and it belongs to the Poaceae family [12]. As this plant adapts well to a variety of climatic zones, it is planted in different parts of the world including India, Malaysia and China [12]. Barnyard millet is known as *Echinochloa esculenta*. Two types of Barnyard millet are famous around the world. Japanese Barnyard millet also known as *Echinochloa crus-galli* is one of the types and the other type is the Indian Barnyard millet which is generally known as *Echinochloa colona* [12]. Among the species of millet, Kodo millet
is another species that is known in different names across the world (Table 4). The botanical name of Kodo millet is known as *Paspalum scrobiculatum* [12].

At present, various available processing techniques that are available in the world Pseudocereals and cereals are used in the food industry to produce food rich in numerous health benefits and to promote the concept of nutritional food to the modern world. This way it also uplifts the forgotten or the lost culinary dishes that ancestors considered to consume in the ancient time to fulfill the daily food requirement needed in village families.

6. Molecules found in pseudocereals and associated health benefits

6.1 Phytosterols

Phytosterols have a capacity to lower both total and low-density lipoprotein (LDL) levels in food. In high bioavailable tests that contained phytosterols dissolved in oil or egg fat, or emulsified with aqueous solutions [13], consistent LDL lowering was observed. Esterification of phytosterols in long-chain fatty acids increased bioavailability significantly, prompting functional food combinations which contain margarine with phytosterol containing pseudocereals.

The inherent difficulty in extracting phytosterols from plant-based diets has made testing the effects of baseline deficiency in phytosterol levels on diets. As such, very few such clinical tests have been carried out effectively. A recent study indicated a 38% increase in cholesterol absorption when corn oil was purified of phytosterols. Re-addition of the natural phytosterols gave baseline absorption levels, suggesting the LDL content is lowered through phytosterol action.

6.2 Saponins

Saponins are natural surfactants. They exhibit anti-protozoal activity. For example, saponin plant extracts contain protective effects against leishmaniasis. They also exhibit anti-bacterial properties (mostly pronounced against Gram-positive bacteria) at high doses, carried out via way of membranolytic interactions. Saponins also exhibit both humoral and cell-mediated immune system stimulation. As such, they have been implemented as adjuvants in vaccines. While containing the ability to increase intestinal permeability. The emulsification and micelle formation from saponins are expected to increase fatty acid absorption. Ability to reduce blood cholesterol levels. The Masai people's low serum cholesterol levels are attributed to the high number of saponin-rich herbs added to their largely milk and meat-based diets [14].

6.3 Phytoecdysteroids

Phytoecdysteroids contain the potential to decrease the rate of skeletal muscle deterioration via its activity as a mild anabolic agent. The atrophy and muscular fibrosis associated with Sarcopenia can potentially be combated with the aforementioned mechanism of action. In addition to this, Phytoecdysteroids also exhibit potential ability to reduce hyperglycemia and type 2 diabetes. Additionally, plants which contain ecdysteroids were used in traditional ethnobotanical medicinal systems in treatment of osteoporosis. Phytoecdysteroids also contain the capacity to assist people with Seasonal affective disorders, alcohol, and narcotic withdrawals alongside other stress related conditions [15].
6.4 Albumin, chenopodin and lunasin

Albumin exhibits a significant role in fluid distribution throughout the body owing to its colloidal property. It provides a significant level of normal oncotic pressure in intravascular spaces. The abundance and composition of Albumin also support its capacity to act as a transport molecule, or a solute [16].

Chenopodin is the primary seed storage protein of quinoa, and exhibits ability to bind carbohydrates, hemagglutinates erythrocytes, and is resistant to gram-negative bacteria. Chenopodin also inhibits inflammation and pain in vivo models. Lunasin is another peptide variant from quinoa which exhibits reactive oxygen species (ROS) scavenging activity and nitric oxide production inhibition [17].

6.5 Tryptophan

As mentioned above, tryptophan is an important precursor for serotonin and melatonin. Additionally, playing a role in protein synthesis and co-enzyme NAD and NADP storage. Tryptophan is bound to circulating albumin plasma in high levels and exhibits brain-centric functional importance. The essential nature of tryptophan and the high levels of its availability in quinoa make the pseudocereal grain a possible alternative to vegan and vegetarian diets [18].

6.6 Folate

Folates are compounds exhibiting activity like pteroylglutamic acid, acting as an anti-anemia and growth factor. They are essential in carbon transfer steps in several DNA and RNA nucleotides. Advanced folate deficiency levels can lead to macrocytic or megaloblastic anemic conditions, mucous membrane lesions and neural tube defects during pregnancy. There is possibility of it being associated with severe complications such as spontaneous abortions, hemorrhage, separation of placenta from the inner wall of the uterus before birth, and preeclampsia.

The second most prominent condition of folate deficiency is homocysteinemia. It has been linked in recent years to coronary artery disease and stroke. Additionally, being implicated in mental retardation, developmental defects, occlusive disorders, osteoporosis, and dislocated lenses in children, as well as ischemic heart disease. It is part of the trifecta of the B-complex vitamin group alongside riboflavin and vitamin B12. Moreover, high dietary intake of folate has been observed with a decreased risk of carcinoma in situ [19].

6.7 Quercetin and rutin

Rutin exhibits neuroprotective activity, cardioprotective activity, anti-obesity, and antioxidant activity. In addition, rutin can be a potential adjuvant in radioiodine therapy, and shows ability to prevent or decrease the rate of age induced DNA fragmentation caused by apoptosis by inhibiting DNase I. Furthermore, it demonstrates ability to reduce lipid peroxidation in human sperm, contributing to combating male infertility [20]. Rutin has also been associated with lowering risks of arteriosclerosis, capillary fragility, and increased blood pressure. Other beneficial factors include restorative effects on renal diseases, possibly due to the combination of rutin, quercetin, hyperoside and phenolic oligomers found in buckwheat extracts used in studies. It also shows protective effects against gastric lesions and potential to be effective as a DNA protective component in the human diet [21, 22].
6.8 Hyperin

Hyperin exhibits antioxidant, anticancer, antiviral, anti-inflammatory, anti-bacterial, antiparasitic activity, cardio protective attributes, hepatoprotective attributes, anti-histamic, antifungal, apoptosis-inducing and anti-tumor abilities. Hyperin is also important in combating degenerative disease prevention associated with ROS [23].

6.9 Orientin

Orientin exhibits antioxidant activity, antiviral and antibacterial activity, anti-inflammatory activity, vasodilatory and cardioprotective effects, radioprotective effects, neuroprotection, and antidepressant activity, antiadipogenesis (undifferentiated precursor cells differentiating into fat cells) and, antinociceptive activity [24].

6.10 Vitexin and isovitexin

Vitexin and Isovitexin exhibit anticancer ability, antihypertensive ability, antidiabetic activity, anti-neoplastic effects, anti-inflammatory effects, protection against hypoxia and ischemia injury, protection against Alzheimer’s disease, protective effects on learning, anti-depressive qualities, increasing levels of cerebral blood flow, anti-nociceptive activity, anti-convulsant effects, antiepileptic effects, anti-thyroid effects, analgesic properties, protection against endocrine and metabolic diseases, alongside anti-microbial and anti-viral effects [25].

6.11 Kaempferol

Kaempferol is a polyphenol antioxidant which has beneficial effects such as reducing risk of cancer, inducing cancer cell apoptosis, angiogenesis, anti-inflammation, anti-metastatic properties, and preservation of normal cell viability. Kaempferols have also been the target of recent nanoparticle coating to increase bioavailability due to the low natural occurrence of the substance in vivo. This is due to its poor dissolution in many solvents. However, the clinical properties encourage nanoparticle coating and investigation of the nano-chemopreventive aspect of kaempferol in patients, and further randomized, double blind, clinical testing [26].

7. Conclusion

As an Introductory chapter to this book, it is hoped that the readers will recognize the importance of the cereals highlighted herein and see them as means of imparting nutritive properties and health benefits. In times of trouble, it is possible that nutritionists and food technologists alike would have to look into the past and sought assistance from native grains and cereals which have enabled our ancestors to receive their nourishment. It is only through history that we can learn and un-learn our practices to look forth into a brighter future.
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