



SEED SPROUTING: A WAY TO HEALTH PROMOTING TREASURE

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ABSTRACT

Seed sprouting is gaining importance commercially because it not only improves the nutritional and antioxidant value of seeds but also removes some anti-nutrients like enzyme inhibitors in them and thus makes them safer for diet. Sprouts are the richest source of proteins, carbohydrates, fats, vitamins, minerals as well as secondary metabolite composition (including phenols, flavonoids, steroids and alkaloids) and thus serve as a better source of nutrients and antioxidant rich phytochemicals as compared to seeds. Improvement of nutritional and nutraceutical value of seeds by sprouting is beneficial for human health and can be incorporated in Pharmaceutical preparations or can be directly consumed as a functional food. Such dietary constituent are preferred over drugs as comparatively they pose very little or no possible side effect even though consumed for long time. Due to their simple and inexpensive solutions to the global health problems their use in prevention and treatment of common oxidative stress linked diseases such as diabetes, cardiovascular disease and certain cancers is emerging. However, there remains much work to be done for an optimal outcome and in gaining their dietary acceptability as drug if handled properly in accordance to safety guidelines

Key Words: Seed sprouting, Bioactive compounds, Oxidative stress, Antioxidant activity, Functional food

INTRODUCTION

Sprouts are four to ten days old seedlings formed from seeds during germination and are termed to be authentic “super” foods, that are really easy to grow, and don’t require an outdoor garden. Sprouts mainly originate from the *Leguminosae* family and there are different varieties of sprouts existing in the market, such as the alfalfa, mung bean, radish, and soy sprouts [1]. As the sprouts are consumed at the beginning of the growing phase, their nutrient concentration remains very high [2]. They have long been used in the diet as “health food”. It has been widely reported that sprouts provide higher nutritive value than raw seeds and their production is simple and inexpensive [3]. Although the use of sprouts as a food source for man is as old as the use of seeds, it is only in recent times that science has begun to unravel the chemistry of a sprouting seed, and its potential significance in both human and animal nutrition. Epidemiological studies have shown that consumption of sprouts may help to protect against certain chronic diseases and cancers. Due to the high content of bioactive agents that function as natural antioxidants and aid in cancer prevention[4]. Thus, consumption of sprouts can bring about a host of

health benefits. However, due to number of outbreaks associated with sprouts due to presence of pathogenic organisms, proper safety guidelines should be followed.

DISCUSSION

Nutritional benefits of sprouts

When a seed sprouts, the original composition essentially changes during the germination process and the nutrient-density of a seed is enhanced at the expense of calories. The stored food and enzymes needed for growth of the mature plant are mobilized. The protein, carbohydrate and fat are broken down to free amino acids, simple sugars and soluble compounds [5]. The quantity of the protein fraction significantly changes; the proportion of the nitrogen containing fractions shifts towards the smaller protein fractions, oligo-peptides and free amino acids. Beyond this, the quantity of the amino acids (some of them increase, others decrease or do not alter) is altered and some of the non-protein amino acids are also produced during germination. In consequence of these changes, the biological value of the sprout protein increases, and

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greater digestibility has been also established in the animal experiments. The vitamins including A, B-complex (B-12), C, E and K, increase to meet the growth needs of a young plant whereas, the essential minerals including calcium, magnesium, iron and zinc are supplied in organic form, “chelated” for better assimilation [6]. The composition of the triglycerides also changes, owing to their hydrolysis to free fatty acids originates and can be considered as a certain kind of pre-digestion. Generally, the ratio of the saturated fatty acids increases compared to unsaturated fatty acids, and the ratio within the unsaturated fatty acids shifts to the essential linoleic acid. The quantity of the anti-nutritive components such as the flatulence-producing β -galactosides, trypsin and chymotrypsin inhibitors, which affect the digestion of proteins, are reduced after germination, while as the utilization of the macro and micro elements are increased due to germination [7,8]. Furthermore, in addition, to being a rich source of nutritional compounds, the sprouts contain as many phytochemicals (sulphoraphane, sulphoraphene, isothiocyanates, glucosinolates, enzymes, antioxidants, vitamins) as an entire plant. Research has shown that phytochemical rich foods possess diverse disease preventive and health promoting properties [9]. Therefore, the improvement of nutritional and nutraceutical value of seeds will be beneficial for human health [10]. In the last decades of the past century, the attention of experts dealing with the healthy nutrition turned more and more towards the determination of the biological value of the nutritionally rich sprouts [11]. Thus, overall germination can lead to the development of such functional foods that have various positive effects on the humans and thus can be helpful in maintaining the proper health [12].

Enhanced phytochemical composition of seeds due to sprouting

During the recent years, an increased interest in the area of research related to secondary metabolite production during the germination process has arisen, which can have valuable health promoting properties and can act as bioactive or functional components in foods. All this requires knowledge and know-how of the germination process and the biochemistry behind it. Among the secondary products of plant metabolism, phenolic compounds have attracted more and more attention as potential agents for preventing and treating many oxidative stress-related diseases [13]. Several studies have been conducted to compare the phenolic content, flavonoid content, antioxidant activity and antioxidant enzyme activity in seeds and sprouts of various leguminous plants. In a recent study, Chon *et al* [6] studied the effect of sprouting on total phenols and antioxidant activity of soybean, mungbean and cowpea and observed that sprouting increased the nutritive value of seeds, in terms of phenolics and flavonoids in a natural way. The total phenols content and total flavonoid levels were found to be highest in soybean sprout extracts, followed by cowpea and mung bean sprout extracts while DPPH (1,1-di-

phenyl-2-picryl hydrazyl radical) free radical scavenging activity was higher in cowpea or mung bean sprouts than in soybean sprouts. Similar kind of results were also obtained [14] while demonstrating the effect of sprouting on phenolic content and antioxidant activity in chickpea seed. Guoet *al* [15] also reported that germination dramatically increased total phenols, total flavonoids and antioxidant activity in mung bean sprouts in a time dependent manner, upto 4.5, 6.8 and 6 times higher respectively than the original concentration of mung bean seeds. In another important study, total phenolics, quercetin and ascorbic acid in buckweed sprouts were reported to be maximized on 8th day of germination, when compared to their un-germinated counterparts [16]. Likewise, fenugreek sprouts have also been found to show significant increase in their total phenol content as well as their antioxidant activity through elicited sprouting [10, 17, 18].

Natural elicitors also play a great role in increasing the phytochemical content in sprouts. Recently, Perez-Bablilbrea *et al* [19] proved that elicitation of broccoli sprouts with salicylic acid solution increased their flavonoids. In the salicylic treatments flavonoids content including rutin and quercetin of buckwheat sprouts was found to maximise drastically on seventh day during the germination process [20]. Literature survey also suggests that the germination caused a clear increase of saponin content of seeds as the germination proceeds. In one of the studies, Jyothi *et al* [21] reported that compared to seeds, the saponin content was increased to almost 3.2 times after soybean germination. In parallel to this, while studying the saponin make up of fenugreek plant at various stages of growth along with the different parts of the seeds, the seedlings were found to have the highest diosgenin (and other steroid saponin) content, compared to all other stages of growth [22]. In a recent report, Guajardo-Flores [23] concluded that the saponin concentration was increased in sprouts and cotyledons of germinated black beans to 1.9 and 2.1-fold, respectively.

Germination, in addition to cause increase in protein content, dietary fibre, vitamins and bioavailability of trace elements and minerals, is one of the most common processes for the reduction of some anti-nutritive compounds, [24]. In one of the study, in comparison to their seeds, the anti-nutritional factors of lupin sprouts including oligosaccharides (RFOs), alkaloids, globulin and residual fraction content showed a clear decrease during the germination process whereas, a distinct increase of their non-protein fraction was observed [25]. A decrease in trigonelline content (alkaloid) in germinating beans, lentils and peas as well as in cotyledons of germinating mungbean (*Phaseolusaureus*) seeds has also been documented [26]. Kamal and Ahmad [27] also observed a time dependent decrease of alkaloid content in *Nigella Sativa* during germination.

Health benefits of sprouts

Currently, there is much work underway to develop proper treatments for various oxidative stress related diseases. The seeds and sprouts represent excellent examples of such functional foods, defined as lowering the risk of various degenerative diseases including diabetes and several types of cancers [6]. Therefore, the consumption of seeds and sprouts has become increasingly popular among people interested in improving and maintaining their health status by changing dietary habits. A number of reports documented till date supports that sprouts can act as a potential anti-diabetic functional food. One of the recent studies on phenolic enriched pea sprouts suggests them to possess much higher hypoglycemic activity than their seeds, in relation to diabetes management. Sprouts including mung bean sprouts [28, 29], broccoli sprouts [30], sunflower sprouts [31], buckwheat sprouts [32], *Macunapruriens* sprouts [33] and chickpea sprouts [34] have been demonstrated to exhibit a strong antidiabetic activity under *in vivo* conditions. In a four weeks randomized double-blind clinical trial, broccoli sprouts have been found to improve insulin resistance among type 2 diabetic human patients [30]. Similarly, anti-diabetic mung bean sprouts improves glucose tolerance and increases insulin immunological reactivity as five weeks dietary intake of mung bean sprout has been reported to lower blood glucose, cholesterol and triglycerides in diabetic KK-A(y) mice [35]. Likewise, wheat sprouts are reported to be therapeutic for diabetes through the stimulation of insulin secretion [34]. As dietary sprouts possess potential benefits to ameliorate blood glucose levels, and reduces the production of hazardous AGEs that damage tissue physiology. Thus, consumption of sprouts in diet can be also helpful to decrease the incidence of secondary complications associated with diabetes [37]. In this regard, sunflower sprouts are anti-glycative and it potentially inhibits the formation of advanced glycation end products and strongly scavenges damaging free radicals caused by excess blood glucose [38].

Sprouts are also known to improve serum lipid profile and protect against coronary diseases. In one of the study, buckwheat sprouts on the eighth day of germination are reported to contain optimal nutrients for lowering plasma cholesterol and triglyceride levels (39). The sprouts of broccoli [40], alfalfa [41], chickpea [34], and radish [42] also significantly improve fat metabolism, reduces blood cholesterol and lowers blood glucose levels. They are known to significantly increase the survival rates by reducing inflammatory hazards that precede obesity [43]. Dietary sprouts also possess protective effects against various types of cancers. Broccoli sprouts have been found to inhibit the development and growth of lung cancer, skin tumour urinary bladder cancer, prostate cancer cells, ovarian cancer and breast cancer [44, 45, 46]. Likewise, Japanese radish sprouts are reported to prevent breast cancer and flaxseed sprouts inhibit hu-

man breast cancer cell growth [47]. Similarly, antidiabetic mung bean sprouts suppresses human melanoma tumour and anti-diabetic wheat sprouts induces apoptosis of human cancer cells [48]. Thus, when handled and distributed in accordance to safety guidelines, sprouts are affordable and accessible solutions to the global burden of chronic diseases.

CONCLUSION

The present review indicates that germination can lead to the development of such type of foods which have various positive effects in the humans. If proper interventions are utilized to minimize pathogenic microbes and other risks in sprouts, such metabolites enriched foods can be incorporated in pharmaceutical preparations for maintaining optimal human health or can be directly consumed as a functional food. However, there remains much work to be done as their mechanism of action to protect against a certain kind of disease at a cellular, biochemical and molecular level have not been comprehensively defined. A better knowledge on the chemistry of bioactive compounds synthesised during sprouting process, their isolation, their characterisation and finally their molecular interactions with target may have much higher impacts for novel drug discovery.

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