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A Review to Nutritional and Health Aspect of Sprouted Food

Review Article

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Abstract

Sprouts are considered as wonder food and contain antioxidants, vitamins, sulphoraphane, isothiocyanates, enzymes andglucosinolatesthat are proved to be effective in the prevention of cancer, or in the therapy against cancer. Because of the nutritional and health benefits of sprouts have become better known, bakers, chefs, athletes, food manufacturers and others are all looking at different ways to incorporate sprouts into popular foods. During germination the original composition of the seeds essentially changed. The aim of this review is to summarize the chemical composition and potential health benefit of sprout grain in human nutrition.The quantity of the protein fractions changes, the proportion of the nitrogen containing fractions shifts towards the smaller protein fractions, free amino acids and oligopeptides. In addition, the quantity of the amino acids composition changed; some of them increase, others decrease or do not alter during germination, and non-protein amino acids also are produced. Moreover, sprouts are outstanding sources of protein, vitamins and minerals and they contain such in the respect of health-maintaining important nutrients like glucosinolates, phenolic and selenium-containing components in the Brassica plants or isonflavons in the soya bean. Evidence from human studies that enzyme systems in our cells required for detoxification of cancer-causing substances can be activated by compounds made from glucosinolates found in brussel sprouts. In consequence of these changes, the quantity of the anti-nutritive materials decreases and the utilization of the macro and micro elements are increased owing to germination. Thus, 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.

Keywords: Composition; Effect; Nutritional Value; Sprouts.

List of Abbreviations: Ascorbate peroxidase; APX, Guaiacol peroxidase; POX, Cow pea sprouts and catalase; CAT, Superoxide dismutase; SOD, Tricarboxylic acid; TCA, Levo-dihydroxyphenylalanine; L-DOPA, Protein hydrolysates; FPH, Lactoferrin; LF, Oregano extract; OE, Oral hypoglycemic drugs; OHG, Gallic acid equivalent; GAE, Selenomethyl-selenocystein; SeMSC, butylated hydroxyanisole; BHA.

Introduction

Sprouts are forming from seeds during sprouting. The most Common food sprouts include:Pulses, Cereals, Oilseeds, Brassica (cabbage family, Umbelliferous vegetables (parsley family), and Allium (onions). All viable seeds can be sprouted, but some sprouts should not be eaten raw. The sprouts are outstanding sources of protein, vitamins and minerals and they contain such in the respect of health-maintaining important nutrients like glucosinolates, phenolic and selenium-containing components in the Brassica plants or isonflavons in the soyabean. As the sprouts are consumed at the beginning of the growing phase, their nutrient concentration remains very high. In the sprouts besides the nutrients phytochemicals, vitamins, minerals, enzymes and amino acids are of the most importance as these are the most useful in the respect of the human health [1-3]. Sprouted legumes are a time-honored way to avail plenty of essential nutrients like total proteins, bio-available vitamins particularly C and B, minerals especially calcium and phytonutrients, which are protective and disease preventing molecules They contain several antioxidants such as vitamin C and E, phenolic compounds and reduced glutathione which are considered to be natural antioxidants, representing an important group of bioactive compounds. Dietary antioxidants may play an important role in protecting the cell against damage caused by free radicals. Consumption of food containing antioxi-

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dants may prevent some diseases and therefore, it is very important to determine their antioxidant capacity in order to estimate their effect on oxidative stress in living beings [5]. Dietary antioxidants protect against reactive oxygen species in the human body by several mechanisms. Unlike most other vegetables, which start to lose their vitamin content as soon as they are picked, sprouts, continue to grow and to form nutrients. During the germination the amount of the antinutritive materials (trypsin inhibitor, phytic acid, pentosan, tannin) decreases and after the germination also compounds with health-maintaining effects and phytochemical properties (glucosinolates, natural antioxidants) could be detected that can have a considerable role among others also in the prevention of cancer. Thus, germination can lead to the development of such functional foods that have a positive effect on the human organism and that help in maintaining the health [9].

Effect and Composition content of Sprouts

Effect of tannins

It has been reported that the tannin content was reduced significantly in germinated seeds. In germinated kidney bean, the loss of total phenol and tannin content can be as high as 96% (Shimelis E A and Rakshit S K. 2007). They observed a reduction in tannin content after germination, which was a result of formation of hydrophobic association of tannins with seed proteins and enzymes. In addition, loss of tannins during germination also may be due to the leaching of tannins, into the water. It could also be due to washing during germination and binding of polyphenols with other organic substances such as carbohydrates or proteins. During the period of soaking prior to germination, the enzyme polyphenol oxidase may be activated, resulting in degradation and consequent loss of polyphenols. The decrease might also be due to breakdown of protein-tannin complexes and release of free tannins into soaking water during sprouting. Tannins, which are usually present in the testa layer of seeds, have been recognized as toxic factors. These are known to inhibit several hydrolytic enzymes, such as trypsin, chymotrypsin, amylases, cellulases and β-galactosidase. In addition they bind proteins and form tannin protein complexes, thus making proteins unavailable. Tannins have also been found to adversely affect the nutritive value of black beans by decreasing the digestibility of proteolytic enzymes.

Nutritional sprouts content of the Sulforaphane and isothiocyanate

The bioactive components of the sprouts of the Brassica plants are the glucosinolates and their products the isothiocyanates as well as the phenols, vitamins and minerals. To the vegetables of the Brassica plants consumed by the humans belong the broccoli, cabbage, Brussels sprouts, cauliflower, chinese cabbage and radish. The Brassica plants contain carotenoids, vitamin C, fiber, flavonoids and such health-protecting substances as the glucosinolates [22, 23]. In the broccoli sprouts the most important glucosinolate is the glucoraphanine that is hydrolyzed by the microflora of the intestine into isothiocyanate and sulforaphane. In the plants the mirosinase enzyme hydrolyzes the glucosinolates mainly into isothiocyanates. These isothiocyanates have different biological effects: some of them damage the liver or are goitrogen, the others have antibacterial, fungicide and anticancer effect [24-27]. The non-germinated seeds have the highest glucosinolate content that decreases in the sprouts. The Brassica sprouts at age of 3 days contain 10-100 times more glucoraphanine than the matching ripe plant [8-29] due to which even a small amount of cabbage sprout reduces the risk of cancer, and is equally effective like a higher amount of the same plant [30, 31]. Sulforaphane in different experimental models both in vivo in animals and in vitro in various cell cultures reduced the dfferent forms of cellular proliferation, maybe by the activation of the enzymes that detoxicate the compounds causing cancer [32-35]. The broccoli sprouts and also the plant itself are considered a very good source of sulforaphane that occurs in the broccoli sprouts in a concentration of above 105 mg/100 g whereas in the broccoli plant in a concentration of 40-171 mg/100 g in the dry matter [34, 36]. Different researchers studying the beneficial effects of the broccoli sprouts and sulforaphane claim that due to its indirect antioxidant properties it strengthens the enzymes taking part in the antioxidant defence of the cells and detoxicates the carcinogen ones reducing by this the possibility of development of a cancer in the body [30, 37, 38]. Clarke et al. examined the anticancer effect of sulforaphane in case of broccoli, cabbage, Brussels sprouts and cauliflower [39]. It was established that sulforaphane occurs in an especially high concentration in the broccoli and broccoli sprout and due to its high isothiocyanate content reduces the risk of cancer including intestine and prostate cancer.

Nutritional sprouts content of glucosinolate

The two kinds of methionine glucosinolate have an extra sulfur atom in a different oxidation state in the side chain. These are forming a redox system (glucoraphenine, glucoraphasatine), which differs from the glucoerucinglucoraphanine system in one double bond only. There is a difference in the radical-capturing capacity of the two systems [32, 33]. Lepidiumsativum sprouts grown in light contain during the first week of the germination high concentration of benzylglucosinolate, and only in traces 2-phenethyl glucosinolate which finding involves a further vegetable with its bioactive compounds into the circle of vegetables with health-maintaining effect [40, 41]. White mustard is commonly consumed fresh worldwide due to its special spicy taste. These vegetables contain several health-protecting compounds such as carotenoids, vitamin C, fibres, flavonoids and glucosinolates [32, 42]. In the white mustard seeds and in the lyophilized sprout among the glucosinolates the glucoerucin is the main component. In contrast to other glucosinolates such as glucoraphanine, glucoerucin has both direct and indirect antioxidant effect due to which consumption of the white mustard and its sprouts is very useful for the human health [32, 33]. Interesting members of the glucosinolate-containing Brassica family are the wild mustard and Turkish mustard, both of them are rich in such bioactive phytochemicals as phenols, flavonoids and vitamin C, each of them are present in the seed, the root and in the three, five and seven days old sprouts [42]. Methanolic extract of the radish sprout has a very high antioxidative activity owing to the different sinapic acid esters and flavonoids with very high radical-capturing capacity as the basis of their biological activity. Clarification of the applicability, transport and metabolism of these glucosinolates is the precondition of the understanding of the mechanism of the protective effect on the human organism [25]. If mirosinase of vegetable origin is present in the diet, the glucosinolates hydrolyze in the intestine. If the mirosinase is inactivated by heat prior to the consumption, the ionic feature of the glucosinolates prevents them from entering the intestine where they are metabolized by bacterial enzymes [25].

Flavonoid content of the nutritional sprouts

The different conditions of the seed sprouting have effect on the flavonol content. The highest miricetin, merin, quercetin and camphorol content in the radish and lucerne sprouts was measured when the sprouting was done in dark at 20°C. Neither an increase of the germination temperature up to 30°C nor a decrease of that down to 10°C affected the effciency of the flavonol synthesis. Similarly, neither a UV nor an IR radiation for between 20 min 24 hours increased significantly the flavonol content of the sprouts compared to the seed. The economical importance of the family of the leguminous plant is obvious as many plants of this family are used as food and feeding stuff. Very precious vegetables both in the animal and human nutrition are the broad bean, mungobean, pea, chick pea, lupine and the lentil sprouts. Soybean is one of the most important food seed in the Asian countries, beneficial effect of foodstuffs made of it is known. It was also reported that the phenolic components in the sprouts vary according to the growing conditions, and it was also established that the light can stimulate the production of the phytochemicals including the higher isoflavon content in the soya sprouts. Sprouted buckwheat for a period of 1-10 days in a glass house under low light conditions and determined the chlorogen acid and flavonoid content including the C-glucoside flavons (orientin, isoorientin, vitexin, isovitexin) as well as rutin and quercetin. Rutin content of one meal portion (on average 20-30 mg/g) was 30 times higher than in the root and pericarp. On the basis of their investigations they recommend the consumption of the buckwheat sprouts during the everyday meals.

Nutritional sprouts content of Phytic acid and phytase

Seeds and four-day-old sprouts of four Brassica varieties (little radish, radish, white mustard and rape) were established to contain inositol hexaphosphate that is called phytic acid or phytate in the salt form. This component proved to be biologically active and potentially useful in the respect of health as it reduced the blood sugar level, the amount of cholesterol and triglycerols, reduced the risk of cancer development and heart diseases [44]. These contain high amount of tiamin, riboflavin, Ca, Mg, Cu, Mn, Fe and Zn as well as dietary fibres,that makes possible the development of a new potential foodstuff. Sung et al. examined the effect of the germination temperature at 10, 20 and 25◦C, in a 6–10-day interval for barley seeds on the phytase enzyme production[56]. The growing rate and protein production of the barley plants increased with increasing temperature. Using SDS PAGE (sodium dodecylsulfate polyacrylamide gel electrophoresis) it was established that during the germination period the proteins transformed, some of them disappeared, some of them appeared on the electrophoretogram. At the beginning of the germination the phytase activity was practically null, and showed a significant increase during the sprouting. In the first couple of days it increased to the eightfold value then reduced. The utilizable phosphate content in connection with the activity of the phytase enzyme increased rapidly at the beginning of the sprouting. The protein and phytase production reached their maximum in two days.

Nutritional sprouts content of Carbohydrate

Nodaa et al. examined the physical and chemical properties of the partially degraded starch of wheat sprout. γ-Amylase present in the sprout degrades partially the starch therefore the examinations targeted determination of physical and chemical properties of the starch degraded this way. By determining the swelling ability and viscosity it was found that they considerably decreased, at the same time the digestibility of starch increased due to the glucoamylase activity, which was due to the extremely late harvest. There are also such varieties that are not especially sensitive to the sprouting and that did not show any change even when harvested very late. In case of certain wheat varieties the extremely late harvest did not cause any significant change in the amylase content, in the average particle size, in the behaviour against heat and the lenght of the amylopectin chains. However, using electron microscope it was established that the late harvest can result in small sized and porous starch particles.

Nutritional sprouts content of Antioxidant, polyphenol and vitamin C

Giberenic acid and indole-3-acetic acid have positive effect on the biosynthesis of vitamin C therefore during the sprouting of soybean the vitamin C content of the sprouts increases. The effect of a weak lighting on the ascorbic acid content and the growth of the soybean sprouts was also examined during which the lighting of 12 hours of ultraviolet and 12 hours of red light enhanced the phytochemical quality of the soybean sprouts. In the course of two, three, four, five, six and nine days of sprouting the nutritional value of the lupine sprouts increased significantly owing to the increase of the vitamin C and polyphenol content, at the same time the amount of such antinutritive materials as the trypsin inhibitor and phytic acid decreased. The antioxidant capacity in the germinated seeds increased by around 58–67%. The high-pressure treatment modified somewhat the vitamin C content and also the antioxidant capacity and beyond a pressure of 500 MPa the decrease was significant. Although the treatment of the sprouts at high pressure resulted in a high (15–17 mg/100 g) vitamin C content and also the antioxidant capacity was by around 26–59% higher than for the non-sprouted horse-bean, the high-pressure treatment had only a slight effect on the quality of the freshly consumed sprouts.

Potential to Health Values of Sprouts

Anti-cancer effect of the sprouts

The potential protective effect of the consumable sprouts and their active components against cancer was studied in several in vivo and in vitro model experiments. The results show a positive correlation between the prevention from cancer of several organs and the consumption of the vegetable or its active components. Consumption of Brassica plants especially broccoli is inversely proportional to the development of breast cancer in case of premenopausal women, whereas in case of postmenopausal women only a very little effect or no effect at all was observed, and even the type of the glutathione-S-transferase did not influence the course of the disease. These results emphasize the role of the Brassicae in the decrease of the risk of the premenopausal breast cancer (Ambrosone et al., 2004). Some health-protecting phytochemicals can be found in the sprout in a much higher concentration than in the developed plant (Fern´andezOrozco et al., 2006). These have significant antigenotoxic effect against damage to DNA induced by H_2O_2 as in those people who consumed for 14 days 113 g of cabbage and leguminous sprouts compared to the control diet the risk of cancer reduced. The application of foodstuffs containing bioactive components can lead to the improvement of the food technologies and to healthy nutrition.

Detoxification action

The detox support provided by brussel sprouts is both complicated and extensive. First, there is evidence from human studies that enzyme systems in our cells required for detoxification of cancer-causing substances can be activated by compounds made from glucosinolates found in brussel sprouts. Brussel sprouts are an outstanding source of glucosinolates. Studies show that glucosinolates found in brussel sprouts are the detox-activating substances (Rungapamestry V et al. 2007).

Action against bladder cancer

Isothiocyanates are a well-known class of cancer chemopreventive agents, and broccoli sprouts are a rich source of several isothiocyanates. Munday R reported that dietary administration to rats of a freeze-dried aqueous extract of broccoli sprouts significantly and dose-dependently inhibited bladder cancer development induced by N-butyl-N-(4hydroxybutyl) nitrosamine. The incidence, multiplicity, size, and progression of bladder cancer were all inhibited by the extract, while the extract itself caused no histological changes in the bladder. Moreover, inhibition of bladder carcinogenesis by the extract was associated with significant induction of glutathione S-transferase and NAD (P) H: quinone oxidoreductase in the bladder (Munday R et al. 2008).

Blood sugar regulator

Glycine max seeds when soaked and germinated become highly effective blood sugar regulators. This was observed in 35 volunteer patients with type-II diabetes. All patients except one were taking oral hypoglycemic drugs (OHG) to control their elevated blood sugar level before they started taking soaked and germinated soya bean seeds as a medicine to control their blood sugar. These patients stopped taking OHG during the period of investigation and took only soaked and germinated soya bean seeds as a medicine to control their high blood sugar level. It was observed that soaked and germinated soya bean seeds are more effective than the OHG (Pathak M. 2005).

Parkinson's disease

Fava bean sprouts are a rich source of levo-dihydroxyphenylalanine (L-DOPA) the precursor of dopamine and is used in the treatment of parkinson's disease. Its phytopharmaceutical value was improved by priming the seeds with natural elicitors like fish protein hydrolysates (FPH), lactoferrin (LF) and oregano extract (OE). The elicitors in general stimulated the phenylpropanoid pathway through the pentose phosphate and shikimate pathway and enhanced the production of phenolics (Randhir R and Shetty K. 2003).

Conclusion

Sprouts are forming from seeds during sprouting and are considered as wonder foods. The sprouts are outstanding sources of protein, vitamins and minerals and they contain such in the respect of health-maintaining important nutrients like glucosinolates, phenolic and selenium-containing components in the Brassica plants or isonflavons in the soya bean. As the sprouts are consumed at the beginning of the growing phase, their nutrient concentration remains very high. Compared to the seeds it was established that the sprout due to its transformed protein content which is of higher biological value, the higher polyunsaturated fatty acid content, higher vitamin content and the better utilization of the minerals has a higher nutritional value. During the germination the polysaccharides degrade into oligo- and monosaccharaides, the fats into free fatty acids, whereas the proteins into oligopeptides and free amino acids, which processes support the biochemical mechanisms in our organism. During the germination the amount of the antinutritive materials (trypsin inhibitor, phytic acid, pentosan, tannin) decreases and after the germination also compounds with health-maintaining effects and phytochemical properties (glucosinolates, natural antioxidants) could be detected that can have a considerable role among others also in the prevention of cancer. Thus, germination can lead to the development of such functional foods that have a positive effect on the human organism and that help in maintaining the health.

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