

Alfalfa Seeds and Sprouts – Review of the Health Benefits and Their Influence on Bakery Products

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Abstract: Alfalfa (*Medicago Sativa*) is a perennial flowering plant from the legume Fabaceae family and is nutritionally important due to its chemical composition. Germination represents the process by which the seed passes from a latent state to an active state, it is the moment when chemical and biochemical transformations take place. Alfalfa's bioactive properties can be highlighted more strongly through the germination process of alfalfa seeds, thus, by using alfalfa germs in bakery products, better quality products can be obtained from a nutritive point of view. Germs are a natural source of bioactive compounds with important health effects and are also important due to the fact that they play a role in the prevention and treatment of diseases. Alfalfa sprouts can be used in products such as bakery products to obtain functional foods containing bioactive compounds such as saponins, flavonoids, phenolic acids, vitamins and minerals. The purpose of this research is highlighting the booster effect of the germination process on alfalfa seeds bioactive potential which transforms alfalfa sprouts in highly healthy ingredients.

Keywords: bakery products, bioactive compounds, germination, *Medicago sativa*, sprouts.

Introduction

An ingredient like alfalfa (*Medicago sativa*), would be hard to believe that can be used in the food industry in bakery-pastry products. However, through its properties, alfalfa can lead to the improvement of a food product due to its properties.

Germs have been associated with a variety of biologically active constituents with valuable health benefits. For example, in the article written by Shi et al., it was stated that increasing consumption

of alfalfa sprouts is due to their high content of saponins and other useful bioactive compounds present in the germinated seeds (Shi et al., 2014). Such compounds are known to possess properties such as antioxidant activity, antiviral activity, immune stimulatory activity, and antidiabetic activity among other functions in both humans and animals (Shi et al., 2014).

Over the decades, there have been significant advances in germ production. More elaborate technologies have been evaluated, and examinations of various methods of improving the functional properties of edible plant germs are still ongoing (Świeca and Dziki, 2015).

Germs are a natural source of various bioactive compounds with various beneficial health effects in the prevention and treatment of various diseases (Chiriac et al., 2020).

The purpose of this review is to reveal the importance of the consumption of alfalfa seeds and sprouts due to their content of biologically active compounds and also to identify their applicability in the bakery sector.

Plant characteristics and chemical composition

Alfalfa is of interest to the food industry due to its nutritional value. Alfalfa seeds do not contain gluten, are rich in fat proteins, have high fiber content, and is rich in polyunsaturated fatty acids, vitamins, and minerals (Giuberti et al., 2018).

Some scientific studies demonstrated that the chemical composition of alfalfa is influenced by the stage of maturity and the form in which it is used, thus, the seeds have a slightly different chemical composition compared to the mature plant (table 1) (Hojilla-Evangelista et al., 2017; Giuberti et al., 2018).

According to the scientific study carried out by Hojilla-Evangelista et al., 2017 alfalfa contains amino acids such as histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, tyrosine, valine, alanine, arginine, aspartic acid, asparagine, cystine, glutamic acid, glutamine, glycine, proline and serine (Hojilla-Evangelista et al., 2017). These amino acids are found in the plant and seeds in different concentrations.

In addition to its rich protein content, alfalfa also has valuable fats, especially essential fatty acids such as linoleic acid (C18:2 omega 6) and linolenic acid (C18:3 omega 3) (Giuberti et al., 2018).

Table 1

The nutritional composition of alfalfa

	Moisture content	Protein	Fat	Fiber	Ash	UM
Green forage	80.0*	5.2	0.9	3.5	2.4	%/100g*; g/100 g
Whole meal	7.5*	16.0	2.5	27.3	9.1	%/100g*; g/100 g
Leaf meal	8.0*	20.4	2.6	17.1	11.5	%/100g*; g/100 g
Dried stems, undefatted	61 ± 1	132 ± 2	10 ± 1	-	-	g kg ⁻¹
Dried leaves, undefatted	67 ± 1	261 ± 1	21 ± 0	-	-	g kg ⁻¹
Dried stems, defatted	58 ± 0	134 ± 3	3 ± 0	-	-	g kg ⁻¹
Dried leaves, defatted	113 ± 1	264 ± 2	6 ± 0	-	-	g kg ⁻¹

Adapted after (Mielmann, 2013; Hojilla-Evangelista et al., 2017)

According to a scientific study carried out on dry alfalfa, the fiber content varies between 4.32 to 16.25% for lignin, 16.29 to 36.44 for cellulose and hemicellulose between 5.26 to 19.86%. These percentages were influenced by the season, the harvest period and the variety (Daniël et al., 2008).

The germination process

Germination is an ancient common physical method used to increase the safety and nutritional value of edible seeds, a process that has become increasingly used nowadays for the nutritional valorization of various seeds (Hendek Ertop and Bektaş, 2018; Aloo et al., 2021). The principle of germination consists in the activation of enzymes from a latent seed and the stage that triggers various enzymatic activities that lead to the decomposition of stored proteins, carbohydrates and lipids into simpler forms.(Elkhalifa and Bernhardt, 2010; Aloo et al., 2021).

Seed germination consists in the growth of buds preceded by biochemical processes that activate the hydrolysis of stored nutrients. Due to the fact that germination is a complex process, scientific studies show that the germination process takes place in three phases

depending on the water absorption capacities of the seeds and the microstructure of the seeds (Agbo et al., 1987).

The first stage of the germination process consists of rapid absorption of water, the stage called imbibition, being a necessary process with the role of improving biochemical processes, this stage is preceded by the second stage in which water absorption is reduced, and in the third stage there is an increase in water absorption with the simultaneous protrusion of the radicle from the seed coat (Idowu et al., 2020).

During the germination, processes such as the degradation of sugars, free amino acids and organic acids take place, which is significantly increased (Elkhalifa and Bernhardt, 2010; Gan et al., 2017).

The main purpose of the germination process is to increase the bioavailability of the active compounds in the germinated seeds (Aloo et al., 2021).

The germination stage plays an important role in the final chemical composition of the germinated seeds, and factors such as light, temperature, time and humidity must be closely monitored. In general, germination takes place in the dark, and the temperature is maintained between 10-20°C for most species of seeds, the germination time is determined by the purpose of germination, varying between 3-5 days, the period in which significant changes in chemical composition occur. Currently, several variants and methods of germination are used to improve this process (Dove and Mangan, 2010; Ohanenye et al., 2020; Aloo et al., 2021).

An advantage of the germination process is that through this process some of the antinutrients are reduced. By antinutrients, we mean phytic acid, tannins and polyphenols, with the consequence of decreasing the bioavailability of proteins, minor minerals such as Zn, Fe, Cu and major minerals such as Ca and P (Hendek Ertop and Bektaş, 2018). During the germination process, an activity of endogenous enzymes takes place, thus increasing the ability to degrade phytates (Hendek Ertop and Bektaş, 2018).

In some scientific studies, it was concluded that after a shorter germination period (≤ 36 h) no significant changes occurred in terms of phytic acid reduction, instead, after a germination period of approximately 10 days, substantial reductions in phytic acid were recorded, thus, the germination period is very important in the process of reducing antinutrients (Azeke et al., 2010; Stern et al., 2021).

Alfalfa sprouts as a rich source of biologically active compounds

Germs represent a natural source of different bioactive compounds with beneficial effects on health, which can be used in different forms in the prevention and treatment of diseases (Chiriac et al., 2020). The use of germinated seeds and flours obtained from germinated seeds for bakery and pastry products as well as for other food products is due to the capability of germinated seeds to nutritionally improve the products to which they are added. The health benefits of alfalfa sprouts are summarized in table 2.

Table 2

The health benefits of alfalfa sprouts

Sprouts	Bioactive compounds	Health benefits
Alfalfa sprouts	Saponins	Anticancer and antimicrobial activities
	Flavonoids	Anti-inflammatory, antioxidant, and antidiabetic activities
	Phenolic acids (ferulic, garlic, caffeic)	Anti-inflammatory, antioxidant, and antidiabetic activities
	Vitamins C and E, and beta-carotene	Antioxidant and anti-obesity activities
	Trace elements (Cu, Mn, Se)	Antidiabetic and antioxidant activities enhance the functions of enzymes
	Cumestrol	Anti-obesity
	L-canavanine	Anticancer activity
	β -carotene and lutein	Anticancer activity

Adapted after (Aloo et al., 2021)

A particular case in which the benefits of alfalfa sprouts are presented highlights that the alfalfa sprouts include trace elements such as copper, manganese, and selenium, playing a fundamental role in controlling oxidative stress and free radical balance in various physiological processes (Aloo et al., 2021).

Regarding micronutrients, alfalfa sprouts are rich in vitamins from the B complex, vitamins from the C complex, and vitamin E

(Aloo et al., 2021). At the same time, alfalfa sprouts also contain compounds such as flavonoids that have a role in anti-diabetic activity, anti-obesity activity, antioxidant activity, as well as many other biological activities (Fan et al., 2004; Aloo et al., 2021).

Following a scientific study, it was concluded that the nutritional intake of selenium protects against ovarian cancer in postmenopausal women (Chiriac et al., 2020; Terry et al., 2017) and also in other scientific studies, they concluded that selenoglucosinolates exhibit stronger anticancer activity (Tian et al., 2018). Studies revealed the importance of zinc in depressive symptoms, as well as of iron in aspects such as mood and cognition in premenopausal women (Lomagno et al., 2014; Chiriac et al., 2020).

The trace elements have a fundamental role in the control of oxidative reactions and antioxidant/free radical balance in biological tissues (Chiriac et al., 2020). Manganese is an important component and is found in large quantities in alfalfa sprouts, plays an important role in the case of people suffering from diabetes, thus, the high concentration of manganese in alfalfa sprouts helps to stimulate insulin secretion, thus improving the function of insulin in the treatment of people with diabetes (Amraie et al., 2015). Manganese, a constituent of manganese superoxide dismutase (Mn-SOD), is an enzyme that prevents the effects of free radicals on mitochondria (El-Deeb et al., 2016). Also, an important role is represented by Cu, which is a component of cytochrome oxidase and plays a critical role as a free oxygen scavenger (Aloo et al., 2021).

Alfalfa sprouts contain both phenolic and non-phenolic compounds. Gallic acid and caffeic acid are among the phenolic compounds, and among the non-phenolic compounds, the most important component of alfalfa sprouts is represented by saponins, which have an important biological role in the functioning of the body (Cui et al., 2020; Aloo et al., 2021).

In a study conducted to investigate the protective effects of alfalfa saponins on apoptotic cells induced by oxidative stress, it was shown that alfalfa saponins could increase the number of antioxidant enzymes. The antioxidant activity of alfalfa saponins was achieved by restoring GSH homeostasis (Cui et al., 2020). The researchers concluded that alfalfa saponins could function as an inhibitor of cellular oxidative damage or as a potential drug candidate, providing

a new strategy to inhibit oxidative stress-induced cellular apoptosis in monogastric animals (Cui et al., 2020).

Saponins, prosapogenins, and sapogenins have been reported to exert high antimicrobial activity against yeasts and bacterial strains (Avato et al., 2006). Therefore, saponins can inhibit cholesterol esterase, acetyl coenzyme A, and carboxylase enzymes, thus preventing the synthesis of fatty acids in the body (Amraie et al., 2015). The inhibitory function of saponins on fatty acid synthesis helps to balance the ratio between HDL cholesterol and LDL cholesterol (Aloo et al., 2021).

The health benefits of sprouts and their capability to nutritionally improve bakery products

Human exposure to chemicals unsuitable for the body and nanoparticles is inevitable, as these substances are frequently encountered in everyday life. A disadvantage of chemical substances is represented by their cytotoxic effect on the body, which has led to an increase in the number of people suffering from cancer. Due to the high mortality rate of cancer patients, scientists have investigated the role of plant germs in cancer management. Alfalfa contains L-canavanine, a compound that has a strong inhibitory effect against cancer cells (Hudson et al., 2011). Moreover, derivatives of 3-terpenes and 5-flavonoids (Gatouillat et al., 2014), β -carotene and lutein (Almuhayawi et al., 2021), have been reported as anticancer phytochemicals having a role in the prevention and treatment of cancer.

A big issue of our days is represented by multiple health diseases, but one of the most widespread diseases, currently, is diabetes, which is characterized by a high concentration of sugar in the blood, a reaction called hyperglycemia. The main causes of diabetes are defects in insulin secretion or errors in insulin action, resulting in hyperglycemia (Bao et al., 2016). To come up with solutions and treatments for diabetes, researchers are trying to find inhibitors that block or inhibit the hydrolysis of carbohydrates. Among the inhibitors determined by researchers to be effective for inhibiting carbohydrate hydrolysis are enzymes such as alpha-glucosidases (Bao et al., 2016). At the same time, another scientific

research concluded that part of the natural antioxidants of germs can act as a defense mechanism against oxidative stress and inhibit the enzymes that hydrolyze carbohydrates into simple sugars (Baxi et al., 2010; Basha et al., 2017).

Wheat flour is the most widely used flour globally, with most bakery and pastry products being obtained entirely from wheat flour or partially, it is added in certain concentrations. The increased interest of people in the last period for what they consume has determined the bakery industry as well as the pastry industry to constantly improve the products quality. Thus, methods have been tried and are still being studied by which bakery products can be improved from a nutritional point of view and also aimed at obtaining functional products suitable for a wide range of consumers.

Due to the functional properties that germs acquire during the germination process, the use of germs of various types in bakery products has been attempted. Legume sprouts are used to add value to the finished product. It is known that legumes have an important nutritional role in bakery products and that is why the use of powders obtained from legume germs in composites with different flours has been studied.

In a scientific study, the behavior of doughs obtained from wheat flour composites and flours obtained from lentil germ flour and soy germ flour was followed. The study was conducted to help bakery manufacturers to improve recipes according to consumer and technological requirements. The rheological properties of doughs obtained with the help of germinated seed flours were followed and it was concluded that small concentrations of germinated flours can bring improvements from a rheological point of view (Ungureanu-Iuga et al., 2021).

Also, another scientific study concluded that the addition of sprouted seed flour is recommended for use in bread recipes to improve its nutritional value (Ertaş and Bilgiçli, 2012).

This addition also influences the characteristics of the dough, but also on the qualitative characteristics of the bread, thus, scientific studies show a positive influence of the addition of germinated seed flour on the rheological characteristics of the dough, in particular, due to the increased water retention capacity (Patrascu et al., 2016).

However, there are also some types of sprouted seed flour whose addition to bread has led to a decrease in water retention capacity, so it is very important to monitor the water absorption capacity of the added flour, as it plays an extremely important role in the quality of the finished product.

In another scientific study, the nutritional, functional, and sensory effects of germinated wheat grains and the flour obtained from those grains were tested at increasing germination times to understand the impact on wheat grown using organic practices. Positive relationships between D-glucose, sucrose, and maltose and germination duration resulted in increased perceived sweetness (Stern et al., 2021). This suggests that the inclusion of sprouted flour could limit the need for added sugar and sprouted whole wheat bread could be tastier than whole wheat bread without sprouted wheat.

A scientific article in which alfalfa flour was used, concluded that it has the role of improving the chemical composition of the final pastry product. The article made by (Ullah et al., 2016) had the purpose of highlighting the nutritional properties of alfalfa seed flour, which is used for biscuits manufacturing. Wheat flour was replaced in proportions of 5%, 10%, 15% and 20% with alfalfa seed flour. Improvements were reported at the level of nutritional value, in the case of protein, fat, fiber, ash and mineral content (Ullah et al., 2016).

From a rheological point of view, doughs obtained from wheat flours germinated for different periods had poorer quality as the germination time was longer. Following the sensory analysis, there was openness on the part of the consumers, who were not necessarily skeptical about consuming ordinary bread made from wheat flour obtained from sprouted grains.

Conclusion

- Alfalfa is a very important plant from a nutritional point of view, being very common in animal feed, but scientific studies have shown that it can also be used in food products.
- In human nutrition, it can be used in various forms, as protein powder, seeds or sprouts flour in various preparations. Numerous scientific studies have concluded that germination is a valuable process because there are improvements in the nutritional value and also there are improvements in the level of bioactive compounds.

➤ Alfalfa sprouts have numerous health benefits due to their chemical composition and their biomolecule content such as polyphenols, saponins and minerals. Due to the chemical composition and health benefits alfalfa sprouts can be used in bakery and pastry products to obtain a functional product with multiple benefits from a nutritional point of view.

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