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Effect of Germination on Nutritional Quality of Soybean (Glycine Max)

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Abstract: *The Soybean grains were germinated under controlled condition and its soaking and germination time was finalized for the best results. The ungerminated and germinated flours were evaluated for its chemical (proximate) and physicochemical properties. It was found that the germination of soyabean reduced the carbohydrate content from 22.1 to 17.9 (%), starch 12.23 to 10.21 (%), amylopectin 6.2 to 4.4 (%), ash content from 4.95 to 4.59 (%), fat 24 to 10 (%), falling number 341 to 98, and oil absorption capacity 3.45 to 3.26 (%) respectively. The germination of grains increased the moisture content from 10 to 11 (%), total sugar 3.55 to 5.6 (%), reducing sugar 0.45 to 0.61 (%), non-reducing sugar 3.1 to 4.99 (%), protein content 29.09 to 34.99 (%), amylose content 5.8 to 6.4 (%), water absorption capacity 120.4 to 123.4 (%), particle size 0.091 to 0.094 μm and water solubility index 16 to 28 (%), respectively. So the present study revealed that germination significantly affects the nutritional and physicochemical properties of soybean.*
Keywords: *Soyabean, Germination, physicochemical properties.*

I. Introduction

Germination of cereals has been used for centuries to soften kernel structure, to increase nutrient content and availability; to decrease the content of antinutritive compounds, and to add new flavours without knowing the biochemistry behind these phenomena. Barley malting is the most widely known controlled germination process, used to produce malt for brewing purposes and food applications [1]. Germination of a grain or seed is a chain of events that commences when viable, dry seeds imbibe water, and terminates with the elongation of the embryonic axis. Upon imbibitions, the quiescent seed rapidly resumes metabolic activity including respiration, enzyme and organelle activity, and RNA and protein synthesis [2] Enzymes are synthesized to degrade storage macromolecules. These reactions lead to structural modification and development of new compounds, many of which have high bioactivity and can increase the nutritional value and stability of grains. Furthermore, many of the developed compounds are flavour precursors participating in the formation of palatable malt flavor.

Soybeans have been consumed by Asians, including the Chinese, for centuries and are often advocated in Western diets now adays because of their beneficial nutritional effect [3] However, soybean seeds contain many antinutritional factors such as lectins and enzyme inhibitors. Germination has been identified as an inexpensive and effective technology for improving the nutritional quality of soybeans. Numerous studies have been done to investigate the effect of germination on antinutritional factors [4].Soybean sprouts are highly digestible and a good source of protein and minerals and have been eaten for a long time in China and other Asian countries as a kind of 'vegetable' to complement a low intake of fruits and vegetables, especially in rural areas of China where seasonal fruits and vegetables are not available all-year-round. Several problems are encountered during the production of soybean sprouts, including yield reduction, quality deterioration and rot occurrence .[5] Germination of seeds is one of the best methods to be utilized in the improvement of nutritional profile of the seed grains and which will be used for the development of various food products, It also improves the bioavailability of the various minerals, vitamins and dietary fibers which are of immense significance from both health as well as nutritional point of view.

II. Material And Methods

Procurement of Raw Material

Freshly harvested good quality raw material of Soyabean was procured from the local market of Sangrur, Punjab and cleaned in unit operation laboratory by using instruments like aspirator, grader etc and also by manual observation.

Germination of grains

Germination of soybean seeds were carried out as per the method described by [6]

Comparative chemical (proximate) Analysis of Germinated and ungerminated Soybean flour.

All the comparative parameters for soybean like Moisture content, Ash content , Total carbohydrate content, reducing sugar, Starch content, Protein estimation Amylose content, Fat content determined by method [7,8]

Physical Characteristics of flours of germinated and ungerminated grains of Soybean

The Physical properties of germinated and ungerminated grains of soybean with the following parameters were determined. Water absorption index (WAI), Oil binding capacity (OBC) as per the method described by [9] and Water Solubility Index (WSI) by [10]

Viscosity of flours

The Brookfield rotational viscometer (Model LVT2, Brookfield Engineering Lab, Stoughton, Mass, USA) has been successfully applied to analyze rheology of pastes, colloidal suspensions and solutions [11] Apparent viscosity (μ_a) of flours of germinated and ungerminated grains of soybean was determined using Brookfield viscometer with spindle No.1 at room temperature at different rpm (6, 12, 30 and 60).

Falling number

Moisture test on a soybean sample that has been selected is done first. A 7 gram ground sample, based on a 14% moisture basis, is used for the falling number test. The total time in seconds it takes the stirrer to reach the bottom including the 60 seconds stirring time is the falling number result, which reflects the sprout damage in the sample. The falling number reading is then recorded.

III. Results And Discussion

In soyabean flour it was observed that the physicochemical characteristics of soybean varied in germinated and ungerminated as shown in Table.1. And the same way the physical properties showed in Table.2.

Table 1: Chemical composition of ungerminated and germinated flours of soybean

Samples → / (%) ↓	Ungerminated Soyabean Flour	Germinated Soyabean Flour
Moisture	10 ± 0.30^a	11 ± 0.26^b
Ash	4.95 ± 0.11^b	4.59 ± 0.12^a
Crude fiber	14.4 ± 0.26^a	18.6 ± 0.27^b
Carbohydrate	22.1 ± 0.26^b	17.9 ± 0.25^a
Total sugar	3.55 ± 0.25^a	5.6 ± 0.24^b
Reducing sugar	0.45 ± 0.24^a	0.61 ± 0.25^b
Non-reducing	3.1 ± 0.25^a	4.99 ± 0.23^b
Starch	12.23 ± 0.24^b	10.21 ± 0.26^a
Amylose	5.8 ± 0.20^a	6.4 ± 0.22^b
Amylopectin	6.2 ± 0.23^b	4.4 ± 0.24^a
Protein	29.09 ± 0.27^a	34.99 ± 0.22^b
Falling Number	341 ± 0.26^b	$98a\pm0.30^a$
Fat	24 ± 0.26^b	10 ± 0.28^a

Values are mean of 3 determination ± S.D. a to e character show significant difference in each row ($P \leq 0.05$)

Table 2: Physical (flour) properties of ungerminated and germinated flours of Soybean.

Samples		Soyabean (u)	Soyabean (g)
Particle size (µm)		0.091	0.094
Water Absorption Index (%)		120.4	123.4
Water Solubility Index (%)		16	28
Oil Absorption Capacity (%)		3.45	3.26
Viscosity (cP)		40	25
Colour	(Yellow)	3.3	3.6
	(Red)	1.2	1.3
	(Blue)	0.1	1
	(TCU)	9.3	10.1

Samples in duplicate were taken and average values are reported (u-ungerminated, g-germinated)

The moisture content of ungerminated and germinated flour samples of soybean varied between 10 % to 11 % (wb) as shown in (Table 1) means moisture content was significantly increased after germination. This finding is similar to the results reported by [12] in germinated legumes (soybean). As germination proceeds, legumes took up water from the surrounding in order for the metabolic process to commence. Dry legumes absorb water rapidly, influenced by the structure of the legume. The increase in water uptake with time is due to the increasing number of cells within the seed becoming hydrated [13] Ash content of soybean flour decreased from 4.95 % to 4.59 % (Table 1). Ash content was significantly decreased in germinated soybeans, parallel to observations of [12,14]. The decrease in ash content represents loss in minerals due to rootlet and washing of the soybean in water to reduce the sour smell during the period of germination [15].

(Table 1) indicated that the total carbohydrate, total sugar, reducing and non-reducing sugar contents of soybean as affected by soaking, germination and heating treatments. The soaking, germination and heating treatments given to soybean grains significantly decreased the total carbohydrate contents 22.1 % to 17.9 %.This was because of active respiration process during soaking and germination. On the other hand, soaking, germination and heating significantly increased reducing from 0.45% to 0.61%, non-reducing from 3.10 % to 4.99 % and total sugars from 3.55 % to 5.60 % due to activities of α-amylase and β-amylase enzymes, which increased with soaking and subsequent germination. The results of soaking, germination and heating related with decrease in total carbohydrate and increase in sugars (total, reducing and non-reducing) in soybean are in agreement with those of [6]. The biological reactions involved in the germination are dependent on the temperature, because the enzymes involved have ranges of action that will retard or accelerate seed germination [2]. The velocity in which the enzymes carry out their functions will interfere in the degrading of the reserved carbohydrates and ATP production, which will be used in forming proteins and other metabolites that originate tissues and cellular compounds that culminate with the protrusion of the rootlets and consequent seedling established [16,17].

The protein and fat contents as affected by soaking, germination and heating are given in (Table 1) The germination of soybean had significantly increasing effect on protein content 29.09 % to 34.99 %. The fat content in present study significantly decreased from 24 % to 10 % after soaking, germination (96hrs) and heating. Similarly the results of soaking, germination and heating of soybean related with decrease in fat and increase in protein are in agreement with those of [6].

Crude fibre was increased in germinated soybean from 14.4 % to 18.6 % (Table 1). In germinated rice, the amount of crude fibre was contributed by the presence of bran layer, an outer layer of rice that contained fibre [18]. Study by [19] demonstrated that crude fibre was decreased in soaked peanut and mung bean, but conversely increased in soaked rice and soybean. This indicates that germination process affect the level of crude fibre during the period of soaking before the actual phase of germination. Therefore, Studies have shown that intake of legumes have many health effects in controlling and preventing metabolic diseases such as diabetes mellitus and coronary heart diseases [20]. Combination of whole grain and legume powder in coronary artery disease patients without diabetes mellitus can reduce fasting levels of glucose and insulin [21]. Germination meanwhile, altered the biochemical composition of legumes. Decrease of carbohydrate level is beneficial to diabetes mellitus patients. In addition, increase of total dietary fiber and decrease of fat content can give benefit to people with cardiovascular disease and hypercholesterolemia.

(Table 1) indicated that the starch content of soybean significantly decreased from 12.23 % to 10.21 % during soaking, germination (96 hrs) and heating. The increased α- amylase and β-amylase activities correspond with the decrease in the starch content, significant increase in amylose content from 5.8% to 6.4% and significant decrease in amylopectin from 6.2 % to 4.4 % in germinated soybean flour and these results are in agreement with those of [22,23] reported that the germination of cereal grains caused extensive changes in the structure and composition of major macromolecular components of the grains. Since gelatinization rates are related to starch composition and structure, the extent of starch modification during grain germination may influence rates of gelatinization. Therefore, improvements in starch degradability possibly due to differences in the degree of modification of starch structure and composition. Changes such as these have been reported by [24,25].

The Pertson Falling Number apparatus was designed to assess the gelatinization of starch and its subsequent hydrolysis by alpha amylase. The ability of a soybean grain to convert its own starch to low molecular weight sugars increases during the germination period due to the production of α and β-amylases. While starch contributes a very high viscosity to ungerminated grain flour, the low molecular weight sugars contribute far less in germinated flour. The Pertson Falling Number apparatus measures this viscosity and assesses the ease with which starch can be converted to sugars during germination. (Table 1) shows the effect of germination on the Falling Number assessment of soybean flour of germinated and germinated grains. No exogenous enzymes were added to these experiments so that at casting the grain was not able to convert its own starch content to sugars. Thus during the soaking, germination and heating stage the starch was gelatinized but without endogenous amylases and with the endosperm almost totally unmodified, the plunger was not able to fall through the slurry. After 12 hrs soaking, 96 hrs germination and heating treatment, there was sufficient modification to the grain, and sufficient enzymatic activity to convert the starch, and the plunger was able to fall quite rapidly through the gelatinized starch. After 96 hrs germination coinciding with considerable modification of the endosperm and development of enzymatic potential, the Falling Number was reduced to a minimum level i.e from 341 to 98. The changes associated with germination are important for improving the nutritional value of the soybean grain flour, and clearly it is possible to measure these changes with the Pertson Falling Number apparatus. These results are in agreement with results obtained through the study by [26].

IV. Conclusion

In the present study germination of soyabean was carried out under the controlled conditions of soaking, germination and heating. Finally the best results were obtained at 12hrs soaking time and 96 hrs germination time. So, soaking was done for 12 hrs and kept for germination up-to 96 hrs. Germinated grains were heated to stop the enzyme activities and to maintain the moisture content and finally the germinated grains were grounded into two types of flour having 60 mesh size particles and 25 mesh size particles. The fine flour of 60 mesh-size was evaluated for its chemical (proximate) composition like moisture content, ash content, carbohydrate, total sugar, reducing sugar, non-reducing sugar, starch, amylose, amylopectin, protein, fat and falling number, and also physiochemical properties like colour, water absorption index, water solubility index, oil binding capacity and particle size. It has been observed that chemical composition and physicochemical properties were significantly affected upon soaking (12hrs), germination (96 hrs) and heating to grains of soyabean.

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