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Quality Assessment of Cereal Based Foods Through Its Rheological, Proximate and Mineral Analysis

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ABSTRACT

Cereal based products made with sprouted grains are associated with various health claims. Addition of sprouted wheat flour serve as a valid alternative to enzymatic improvers or malt for improving the technological performance of wheat flours. Chia seeds are rich in omega 3 fatty acids, high quality protein, fiber and minerals. The current study was conducted to develop composite flour using sprouted wheat flour, chia seeds and flax seeds flour. The composite flour was later used for the development of bread. Rheological, proximate, sensory and mineral analysis were undertaken. It was concluded that the use of sprouted wheat flour improves the nutritional profile of cereal based food. However, the addition of sprouted wheat flour causes the weakening of the dough. This problem was successfully eliminated by the addition of chia seeds which helped the dough to avoid weakening and improve the technological parameters.

Key words: Cereal based foods, sprouted grains, rheological, proximate, mineral analysis

Introduction

Development of functional food in the production of bakery products is growing (Awolu et al., 2016). The role of diet in the prevention of human ailments such as cancer, cardiovascular diseases and obesity has become more evident and many consumers are increasingly seeking functional foods to improve their diets (Omoba et al., 2013). Today foods are not intended to only satisfy hunger and provide necessary nutrients for humans but also to prevent nutrition-related diseases and improve physical and mental well-being (Takachi et al., 2008). To develop functional foods, professionals are always exploring the abilities of different food ingredients/crops (Nothlings et al., 2007). In the lifecycle of a seed, there is a point between when the seed has started to sprout and when it germinates into a full plant. Under certain temperature and humidity conditions, this is the point at which it can become a sprouted grain. The outer bran layer will split open and a small shoot may be visible. This process can also occur with legumes such as lentils. Historically, grains sprouted naturally in storage, though modern farming and processing has stopped much of this. Because there is evidence that there may be additional health benefits to sprouted grains, companies have developed modern techniques to allow grains to sprout. They are now used in cereals, breads, pastas, and other grain products found on grocery-store shelves (Alvarez et al., 2009).

Under ideal growth conditions, ripe grains contain only small amount of enzymes and the resulted flour can be used to produce a wide range of cereal-based products. On the other hand, under non ideal conditions - e.g. when the grains are exposed to prolonged wet or foggy conditions amylases, proteases, and xylanases may be retained or synthesized prior to harvest and as a consequence, the flour is unsuitable for baked products (Hemalata et al., 2014). During sprouting, high levels of hydrolytic enzymes - such as amylase and proteases – are accumulated in the cereal seed, so that the insoluble endosperm starch and protein reserves are hydrolyzed into soluble forms that can be transported to the embryo to meet the needs of the growing plant Significant correlations between xylanase activity levels and sprouting-related parameters, such as a-amylase activity, and viscous properties of flour-water suspensions, have been reported (Dornez et al., 2008). On the other hand, since the nutritional and sensory benefits of sprouting have been extensively documented, using of sprouted grains in food formulations is continuing to gain traction in the marketplace and represents a re-emerging trend in healthy foods (Hubner and Arendt, 2013). Addition of SWF may represent a valid alternative to enzymatic improvers or malt for improving the technological performance of wheat flours (Singh et al., 2011).

Use of flour from whole wheat germinated in controlled conditions improved loaf volume and crumb texture (Rozylo et al., 2011). These positive effects were ascribed to the natural enzymes expressed during the germination process that might decrease or completely replace the quantity of commercial enzymes added to bread formulation (Renzetti et al., 2010). Nonetheless, the use of sprouted wheat as alternative to conventional flour improvers (e.g. enzymes, malt) has not been thoroughly investigated up to now (McCleary & Sturgeon, 2002). Sprouted brown rice may help control blood sugar and promote better blood lipid profiles. The sprouting process also results in a reduction in carbohydrates along with an increase in protein. They also have lower levels of gluten and up to three times the amount of soluble fiber found in non-sprouted grains. Sprouting grains increases many of the grains' key nutrients, including B vitamins, vitamin C, folate, fiber, and essential amino acids often lacking in grains, such as lysine. Sprouted grains may also be less allergenic to those with grain protein sensitivities (Richter et al., 2014). The pace of research is quickening, with studies documenting a wide range of health benefits for different sprouted grains including tendency of sprouted brown rice to cure diabetes, protection by sprouted buckwheat against fatty liver disease, cardiovascular risk reduced by sprouted brown rice, decrease of depression and fatigue in nursing mothers by sprouted brown rice and decreased blood pressure linked to sprouted barley (Donkor et al., 2012).

Bread products made with sprouted grains are literally "sprouting" up everywhere. Moreover, they're often associated with health claims such as increased digestibility, increased absorption of minerals and increased antioxidants (Wu et al., 2013). A higher nutrient count among sprouted grains, then, could have important implications for those on a vegetarian or vegan diet. Another enzyme that can be elevated in sprouted grains is amylase, which breaks down starches into sugars. Increased levels of amylase could heighten a grain's digestibility. Lastly, as with soaking grains, sprouting is said to improve the "bioavailability" of certain grain nutrients by stimulating the breakdown of enzyme inhibitors such as phytic acid (Kruger, 1994). In theory, the better the bioavailability of a certain food, the better your body will absorb minerals such as calcium, magnesium, iron and zinc (all of which are found in grains). Sprouted grains act a little differently in baking than conventional grains, but many of these differences improve the performance of the flour. The enzymatic activity produced during the sprouting process allows sprouted wheat to form stronger gluten bonds in the developing bread dough. Chia seeds have become popular in the health foods market recently, despite the fact that they are actually one of the oldest staples of the Aztec and Mayan diets. Most supermarkets and health food stores sell chia seeds, but they can sometimes be difficult to locate in the store. They can often be found in the produce section or the baking section, however some stores may keep them with their specialty items such as next to the flaxseeds. Consumers are adding chia seeds to baked goods, breads, smoothies, or simply sprinkling on top of salads, cereals, and soups. Because of their mild flavor, chia seeds can be added to a wide variety of dishes. Chia seeds are rich in omega 3 fatty acids, high quality protein, fiber and minerals (Munoz et al., 2013).

Keeping in view the importance of sprouted wheat and chia seeds, the objectives of the present study are, development sprouted wheat flour and chia seed flour, development composite flour and its rheological study, assessment of nutritional profile of different treatments of composite flour and application of composite flour in bread and its nutritional quality assessment.

Materials and methods

The research was conducted in "Grain Quality Testing Laboratory" of Food Sciences Product Development Institute, National Agriculture Research Centre (NARC) Islamabad during 2017. The research was conducted on development of sprouted wheat flour, chia seeds and flax seeds flour. Chia seeds and whole wheat grain purchased from the market. All the analysis was carried out in triplicates.

Preparation of Chia Seed Flour

Chia seed was first cleaned to remove dust and extraneous materials. Then chia seed grains were ground for 3-4 minutes in a grinder and sieved to obtain full fat chia seed flour then it was stored in air tight plastic jar at room temperature before further processing and analysis.

Preparation of Sprouted Wheat Flour

Wheat samples were stored at room temperature before germination. Any broken, damaged and off-color wheat kernels were removed. They were disinfected in a 2% (v/v) H_2O_2 solution for 3 h at room temperature and washed with several changes of distilled water. Then these seeds were steeped for 24 hrs and considered as day1 sprouts. After 24 h of steeping, wheat seeds were germinated sandwiched between two synthetic mesh screens at 25˚C while relative humidity was kept at 80-90%. After 24, 48 when sprouting of one inch was observed sample was removed. After exactly 48 hours' sample was dried at 70°C to inactivate or stop enzyme activity. Upon drying any vegetative parts (roots and shoots) were removed by scrubbing and then screened. Milling of sprouted grains was done successfully by laboratory mill 3100 (Lemar & Swanson,1976).

Treatment plan of Composite flour

Quality of white flour, chia seed flour and flax seed flour was assessed. Treatment plan is shown in Table 1.and Table 2. White flour was replaced with sprouted wheat flour at 5%, 10%, 15% while level of flax and chia seed flour kept 0.5% and compared to control.

Table 1. Treatment plan for 100g of Composite flour

Time			15min		
Treatments	**Patent**	**Chia**	**seed**	**flour Sprouted wheat**	**Improver**
				Flour	
	Flour (WF)	**(CSF)**			
To	100		--	--	0.3
T1	90		5	10	0.3
T2	80		5	20	0.3
T3	85		10	10	0.3
T4	75		10	20	0.3

T0 = Patent flour (Control)

T1 = Composite flour having 5g chiaseed and 10g sprouted wheat flour

T2 = Composite flour having 5g chia seed and 20g sprouted flour

T3=composite flour having 10g chia seed and 10g sprouted flour

T4 =composite flour having 10g chia seed and 20g sprouted wheat flour

Preparation of Bread (Borlaug Variety)

Firstly, ingredients were weighed as prescribed in recipe. After weighing mixing of dry ingredients was done. Following the mixing of dry ingredients, water was added in the mixer and mixed at slow speed for five minutes. Then shortenings were added and speed of mixer was increased and mixing was done for 10 minutes at high speed. Mixing was carried out to distribute the ingredients uniformly and to develop the gluten. After mixing with mixer dough was moulded by hand and placed in greased mold and placed in proofer at 35^{O}C and 85% RH for 90 minutes. After proofing of 90min mould was placed in preheated oven at 250^{O}C for about 20minutes. Now allow the bread to cool at room temperature for 2 hours. After slicing, packed in polythene bags and stored for its analysis.

Rheological analysis

Falling number: Tubes containing the slurry were immersed in the boiling-water bath of the falling number apparatus. The slurry was stirred with the stirrer for 60 seconds then the stirrer was allowed to drop by its own weight through the ground wheat and water slurry. The total time in seconds it takes the stirrer to reach the bottom including the 60-second stirring time is the falling number result, which reflects the sprout damage in the sample. The falling number reading was then recorded (Wang et al., 2010)

Gluten determination: Sample was placed in glutamic washing chamber, it was mixed with 2% salt solution and then removed from chamber and centrifuged. The residue remaining after washing is wet gluten. During centrifugation the gluten was forced through a sieve. The percentage of gluten remaining on the sieve is defined as the gluten index.

Farinogram characteristics. The farinogram characteristics of dough made from blends of breadfruit/wheat composite Flour samples (10–20%) were determined by approved method of AACC (2000) using Brabender Farinograph (Model T 150 E, Ohgduisburg, Germany).

Proximate Analysis

All analyses were performed in triplicates by following the official methods of AACC (2000).

Mositure content: A weighted of amount of composite powder was dried in oven sophisticated with an opening for ventilation and maintained at 130 ^{0}C for 60 minute. Loss of sample weight was expressed as moisture content.

Determination of Ash: Ash content was determined by charring the sample in muffle furnace at 760^{0}C for 90 minutes stay time.

Determination of fat content: Crude fat present in sample was extracted by n-hexane at its boiling point. Afterwards the solvent was evaporated and fat content was determined.

Crude protein determination: Crude protein was determined by kjheldhal apparatus.

Fiber content: For crude fiber determination the food is subjected to acid and alkali step by step, under warm temperature reflux condition, which causes digestion of all organic contents in food except fiber, the extracted fiber is separated from mother liquor through filtration, which is then dried and ignited for its quantitative determination

Determination of Minerals by Atomic Absorption (Air-Acetylene Method)

Varian Atomic Absorption Spectrometer 220 FS was used for the analysis. Prior to analysis of the sample, the instrument was set to zero and calibrated with standard solutions of known concentrations to get the calibration curve. The sample was wet digested or ash dried. After appropriate dilution by de-ionized water or dilute acid, the minerals were determined by Atomic Absorption Spectrometer at suitable wavelengths. Matrix of standard solution was matched to that of test solution to avoid interferences (Stafilov, 2000).

Results and discussion

Physico-chemical Analysis of Raw Material

Chia seed flours were analyzed for determination of moisture content, fat, protein and ash. Data revealed that chia seed flour have moisture 6.21%, protein 12.96%, ash 4.12%. Results obtained are given in Table 3.

Table 3. Mean Values of Raw material (Chia seeds, sprouted and unsprouted wheat flour)

Components	Chia seed flour (CSF)	Sprouted wheat flour	Whole wheat flour
Moisture (%)	6.21	11.06	11.24
Protein (%)	12.96	11.23	12.22
Ash (%)	4.12	1.2	1.15
Fiber (%)	---	5.983	2.795
Fat (%)	---	----	----

Table 2. Gluten determination

Wheat Flour		100 g
Sugar		10 g
Yeast		3 g
Salt		2 g
Water		50 mL
Improver		0.3 g
Shortening		6 g
Conditions:		
Mixing:		
Total mixing time		15 min
Dry ingredients mixing		1 min
Water mixing		7-8 min
Shortening mixing		4-5 min
Salt + Water	mixing	5 min
Proofing:		
Temperature		35^{0}C
Relative Humidity		85%
Time		90 min
Baking:		
Temperature		220^{0}C

Rheology of Raw Material

Table 4. Farinographic parameters of sprouted and whole wheat flour

Treatment	Water absorption (%)	Dough Development time (min)	Stability (min)	Mixing Tolerance index (MTI)	Time to breakdown (min)	Farinograph Quality Number (FQN)
SWF	57.7	2.4	2.2	116	3.1	31
WWF	63.4	6.8	8.1	52	9.8	98

Rheological Analysis of composite flour

Falling Number

It is defined as the total time in seconds from the immersion of the visco-meter tubes into the water bath until the viscometer stirrer dropped down the prescribed distance through the gelatinized suspension. The falling number readings of composite flours are shown in Table 5.

As shown in the Table 5. The values of the falling number decreases by the increase in the addition of sprouted wheat flour as well as chia seed flour. Highest values of chia seeds were seen in the treatment T0 (380) and T4 (62). This shows with the increase in sprouted flour contents the falling number decreases and alpha amylase activity increases because falling number is inversely correlated to the alpha amylase activity.

Table 5. Mean values of Falling No. for all the treatments

Treatments	Falling number
T0	380
T1	73
T2	62
T3	70
T4	62
T0= Patent flour (Control)	

T1= Composite flour having 5g chia seeds and 10g sprouted flour

T2= Composite flour having 5g chia seeds and 20g sprouted flour

T3= Composite flour having 10g chia seeds and 10g sprouted flour

T4= Composite flour having 10g chia seeds and 20 g sprouted flour

Farinographic parameters of composite flour.

Farinograph is used to determine the dough properties of composite flours. For example, water absorption, dough stability, dough development, time and mixing tolerance index etc. Results are presented in Table 6.

Table 6. Mean Values of Farinographic Parameters for all the treatments

	Treatment	Water absorption (%)	Dough Development time (min)	Stability (min)	Mixing Tolerance index(MTI)	Time to breakdown(min)	Farinograph Quality Number (FQN)
	T0	52.1	3.0	13.5	67	11.9	119
	T1	51.5	6.7	8.7	54	9.0	90
	T2	51.2	5.5	7.2	72	7.5	75
	T3	51.1	6.8	7.1	51	9.9	99
	T4	52.2	5.3	6.0	76	7.2	72

T0= Patent flour (Control)
T1= Composite flour having 5g chia seeds and 10g sprouted flour
T2= Composite flour having 5g chia seeds and 20g sprouted flour
T3= Composite flour having 10g chia seeds and 10g sprouted flour
T4= Composite flour having 10g chia seeds and 20 g sprouted flour

Á Table 7. Mean values of Moisture, Protein, Fiber and Ash content of all the Treatments

Treatment	Moisture %	Protein %	Fiber %	Ash %	Fat %
T0	16.53	10.15	0.26	0.475	2.43
T1	15.10	10.43	1.21	0.715	2.93
T2	14.30	10.63	1.68	0.750	--
T3	14.15	10.40	2.38	0.940	4.73
T4	14.31	10.52	1.85	0.955	--

T0= Patent flour (Control)
T1= Composite flour having 5g chia seeds and 10g sprouted flour T2= Composite flour having 5g chia seeds and 20g sprouted flour T3= Composite flour having 10g chia seeds and 10g sprouted flour T4= Composite flour having 10g chia seeds and 20 g sprouted flour

Physical Analysis of Bread

All the bread developed from composite flour was subjected for physical analysis which includes loaf weight, volume, specific volume and baking loss. These results are given in Table 8. There is a significant difference in moisture, ash, fat and fiber contents of all the treatments.

Table 8. Mean values of physical analysis of bread from all the composite flour

Treatment	Loaf wt. (g)	Volume (cm^3)	Specific Vol.	Baking loss
T0	--	--	--	--
T1	228	881	3.05	38
T2	140	381	2.72	14
T3	136	431	3.16	20
T4	139	423	3.10	17

T0= Patent flour Bread (Control)
T1= Bread having 5g chia seeds and 10g sprouted flour
T2= Bread having 5g chia seeds and 20g sprouted flour
T3= Bread having 10g chia seeds and 10g sprouted flour
T4=Bread having 10g chia seeds and 20 g sprouted flour

Proximate Composition of Bread

All the composite flour developed was subjected for bread preparation and proximate analysis of bread was also conducted. These results are given in Table 9. There is a significant difference in moisture, ash, fat and fiber contents of all the treatments.

Table 9. Mean values of proximate analysis of bread from all the composite flour

Treatment	Moisture %	Fiber %	Ash %	Fat %
T0	28.11	0.226	1.205	4.991
T1	31.20	0.419	1.400	5.315
T2	25.08	1.294	1.471	6.436
T3	23.15	2.041	1.4088	8.126
T4	23.36	1.289	1.7755	4.615

T0= Patent flour Bread (Control)
T1= Bread having 5g chia seeds and 10g sprouted flour
T2= Bread having 5g chia seeds and 20g sprouted flour
T3= Bread having 10g chia seeds and 10g sprouted flour
T4=Bread having 10g chia seeds and 20 g sprouted flour

Sensory Evaluation

Bread prepared from different level of sprouted wheat and basil seed flour were subjected to sensory evaluation for color, flavor, texture, taste and aroma by a panel of 5 judges using the 9-point hedonic scale. The mean values of sensory parameters (color, flavor, taste, texture and overall acceptability) of all treatments have been given in sensory Performa.

Table 10. Sensory evaluation Performa of bread

Trt.	Vol. (10)	Crust Color (8)	Symmetry of Form (5)	Evenness of Bake (3)	Character Of Crust (4)	Grain (15)	Color of Crumb (10)	Aroma (10)	Taste (20)	Texture (15)
To	8	7	4	2	3	13	9	8	18	13
T1	7	7	4	2	3	12	8	8	18	12
T2	6	6	3	2	3	13	8	7	16	12
T3	5	5	3	1	2	12	8	6	15	10
T4	4	5	3	1	2	12	8	6	15	10

Mineral Analysis of Zn

Table 11. Mean value of raw material

Raw Material	Zn
SWF	4.05
WWF	2.00
Chia seed	3.51

Table 12. mean value flour

Treatments	Zn
T_0	1.32
T_1	2.50
T_2	1.57
T_3	1.46
T_4	0.70

Conclusion

It was concluded from the experiments that the use of sprouted wheat flour is an economic way to improve nutritional profile of food. However, the addition of sprouted wheat flour which cause the weakening of the dough so chia seeds addition helps the dough to avoid weakening and improve the technological quality of dough.

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