Research Article

Physico-chemical characteristics and anti-nutritional factors of wheat, soybean, oats and pumpkin leaves

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Abstract

The physico-chemical characteristics, proximate composition, nutritional, anti-nutritional and *in-vitro*-starch digestibility of flours were analysed. The results showed that physical parameters of grains such as 1000-kernel weight, water absorption capacity, water solubility index were found to be significantly different in the flours and ranged from 45.1-145.34g, 2.31-3.68 g/g and 4.4-12.88 percent respectively. The proximate composition of wheat, soybean, oats flour and pumpkin leaves varied from 5.69-82.33 percent of moisture, 3.26-33.07 percent of protein, 0.54-17.26 percent of fat, 1.26-3.83 percent of ash, 2.12-6.09 percent for crude fibre, carbohydrate and energy content ranged from 9.73-78.41g, 58.48-512.25 Kcal respectively. The vitamin and mineral content such as β-carotene, vitamin C, calcium and iron content was significantly ($p<0.05$) different in the flours and ranged from 0.96-14.69μg, 0.07-0.51mg, 47.14-289.68 mg, 3.76-8.71mg, respectively. Anti-nutritional factors were significantly different in various flours ranging from 0.08-20.93 mg/100. *In-vitro* starch digestibility varied from 0.08-0.59 percent, significantly different in wheat flour, soy flour, oats flour and pumpkin leaf powder. It was concluded that substitution of these flours at different levels, increased the nutritional quality of food products and prevent from degenerative diseases.

Keywords: wheat, soybean, oats, physico-chemical, anti-nutritional factors, proximate composition

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Introduction

Wheat (*Triticum aestivum*) is the main staple food of large sections of world population. It is the major food produce among all the cereal crops. In India about 85 percent of the wheat is consumed in the form of chapatis [1]. The production of flat breads such as the steam-leavened chapatis from wheat is a major source of nutrients and staple diet common in India, Pakistan and some parts of Africa [2]. Wheat contains all basic nutrients but is deficient in essential amino acids i.e. leucine, lysine and phenyalanine and their bran portion are highly rich in protein, vitamin, minerals and dietary fibre but during milling of wheat the water-soluble vitamins, proteins and dietary fibre is lost. Legumes are second to cereals as important source of dietary fibre. It is also known as ‘‘a poor man’s meat’’. They supply complex carbohydrates, fibre, protein and essential vitamins and minerals to the diet, which are low in sodium, fat and contain no cholesterol. Legumes are second to cereals as important sources of dietary fibre. Some legumes provide a significant quantity of dietary fibre when consumed as whole grains and thus proved as hypocholesterolemic. Legumes are highly rich in protein and have low-glycemic index carbohydrates, essential micronutrients and fibre. One of them is soybean which is a cheap source of quality protein and is superior to all other plant foods because it has a good balance of all essential amino acids and contains a proper amount of methionine [3]. Plant protein can be used to improve the diets of millions of people, mainly low-income groups in developing countries and so can facilitate in normal growth and development. When legumes are consumed in sufficient quantities, they help to manage the level of body fats, blood sugar and cholesterol, but they are deficient in some essential amino acids such as methionine and tryptophan. Cereals and pulses have limiting amino acids - lysine and methionine. In order to offset the deficits of both amino-acids cereals are often combined with pulses to get high quality protein Soybean has superior nutritive value and its flour has 50 percent protein and 5 percent fibre. On the basis of results, yeast-raised breads made with soy flour have compact texture. They have many uses such as soy flour thickens sauces, reduces oil absorption and prevents staling in baked food during frying. Baking food with soy flour gives it moistness, tenderness, a fine texture and a rich color. Oats is considered as secondary crop that is derived from a weed of the primary cereal domesticates wheat and barley. It is consumed as a whole grain cereal and is a valuable part of our daily diet. It is also highly rich in soluble fibres and thus lowers the risk of several chronic diseases. It will help in lowering the blood cholesterol, glucose and insulin concentration because oats contain high total dietary fibre and β glucan so, oats are now well acknowledged for their functional attributes.

During post-harvest time, 20-30 percent losses of fresh fruits and vegetable are there. Our country is largest producers of vegetables and fruits in the world after China. Pumpkin is the most important vegetable grown all over India. It belongs to the family *Cucurbitaceae.* Pumpkins are widely grown in tropical and subtropical countries [4]. The pumpkin leaves are considered as underutilized part of plant, people generally discard leaves as such because they generally consume their vegetable part but not leafy part which is highly rich in all nutrients especially calcium, protein, iron, low in fat and highly rich in antioxidants which help in scavenging free radicals and overcome the risk of various diseases. Wheat, legumes (soybean), oats and pumpkin leaves are highly rich in all nutrients. The increasing incidence of degenerative diseases such as heart ailments, cancers and diabetes call for shift towards food and changes in dietary patterns that provide much more than nutrition. Composite flour technology for wheat supplementation with protein rich materials like soybean and pumpkin leaf powder is good technique to reduce the incidence these diseases. Composite flour is helpful in reducing rate of low-density lipoprotein (LDL), very low density lipoprotein (VLDL) and increasing high density lipoprotein (HDL), lowering blood sugar level, strengthening antioxidant defense system and reduces the risk of various degenerative diseases. The use of the blends of different flours from cereals, legumes, tubers and vegetables for production of different products boost the utility of local crops as raw materials and increase the nutritional quality of various food products.

Material and Methods

Procurement and processing

The sample of wheat (HD-2967), soybean (SL-744) and oats (OL-9) were procured from Department of Plant Breeding and Genetics. Pumpkin leaves (Punjab samrat) were procured from Department of Vegetable Science, College of Agriculture, Punjab Agricultural University, Ludhiana (Punjab).

Processing of samples

Wheat flour, soy flour, oats flour and pumpkin leaves were prepared by following the schematic flow diagram

Wheat	Soybean	Oats	Pumpkin leaves
↓ Cleaning	↓ Sorting	↓ Sorting	↓ Washing
↓ Soaking (2hrs)	↓ Cleaning	↓ Cleaning	↓ Drying (60º C for 8 hrs)
↓ Drying (72 hrs)	↓ Oven drying (60º C for 7-8 hrs)	↓ Dehulling	↓ Grinding
↓ Milling	↓ Decortication/Winnowing	↓ Milling	↓ Pumpkin leaf powder
↓ Sieving	↓ Fine Milling	↓ Sieving	
↓ Wheat flour	↓ Sieving	↓ Oats flour	
	↓ Soybean flour		

Physical Parameters

1000-Kernel weight [5]

Count 250 grains in petridish. Grain was weighed on electronic balance. Then, weighed grain was multiplies with four.

Water Absorption Capacity [5]

The water absorption capacity (WAC) measures the volume occupied by the granule or starch polymer after swelling in excess of water. Weigh 1-3 g sample dispersed in 20 ml distilled water, stirred for one hour. Supernatant was removed and gel was weighed.

$$WAC = \frac{\text{Weight of sediment gel (g)}}{\text{Weight of Dry Solids (g)}}$$

Water Solubility Index (WSI) [5]

It measures the amount of polysaccharides from the flour on the addition of water. It is weight of dry solids in the supernatant.

$$WSI\ (\%) = \frac{\text{Weight of dissolved solid substance in supernatant x 100}}{\text{Weight of dry sample}}$$

Proximate composition

Wheat flour, soybean flour, oats flour and pumpkin leaf powder were analysed for moisture, crude protein, crude fat, ash, crude fibre, carbohydrate and energy content were calculated according to the standardized methods described by AOAC [6]

Moisture [6]

Weigh 5g ground sample was taken in duplicate and dried to a constant weight in crucible in hot air oven for 7-8 hours at 105˚C. The dried material was immediately transferred to a desiccator, cooled and weighed. Moisture was calculated according to the loss in weight of the sample.

Crude protein [6]

Protein (N x 6.25) was calculated by total nitrogen content in samples by Macro kjeldahl method (Kel Plus Classic, Pelican Equipment Inc. India).

Crude fat [6]

Five gram of moisture free sample was transferred to the thimble and was plugged with cotton. Thimbles were placed in the beakers and petroleum ether (40-60˚ C) was put in the flask. A fatty constituent dissolved in the ether was transferred in the beaker. At the end, ether was evaporated and the fat left in the beakers was weighed. Crude fat was extracted by using 1.5 times capacity of soxhlet assembly.

Crude ash [6]

The moisture free 5 g of sample was weighed and placed in pre-weighed dish. The sample was ignited and placed in a muffle furnace for 4 hours at 550°C. Next day the crucible containing residue was placed in desiccator for cooling and then crucible was weighed.

Crude fibre [6]

Crude fibre was determined by acid and alkaline treatment in the samples by using Buchner funnel and refluxer equipment.

Total carbohydrate

Total carbohydrate was calculated by adding the value of moisture, crude protein, crude fat, crude fibre, ash and subtracting from 100.

Energy [6]

Energy content of food samples was calculated by the factorial method.

$$\text{Energy (Kcal)} = (4 \times \text{protein}) + (9 \times \text{crude fat}) + (4 \times \text{carbohydrate})$$

Mineral content [6]

Mineral content was analysed by wet digestion method in hot plate using diacid mixture of nitric and perchloric acid in 3:1for determination of calcium and iron content by inductively coupled plasma emission spectrophotometer (ICP-OES Optima 2100 DV).

Vitamin content
Ascorbic acid [7]

The blue color produced by reduction of 2, 6-dichlorophenolindophenol dye by ascorbic acid and was estimated colorimetrically method. Weigh 2-5g samples and make slurry in pestle mortar using metaphosphoric acid. Pipetted 5ml fliterate, added 5ml acetate buffer and 2ml of 2-6 dichlorophenolindophenol, 10ml xylene in the separating funnel which containing fliterate and shaken well. Two-layer was formed, the bottom layer was discarded and xylene layer was collected in test tube and read in spectrophotometer at 550nm.

β-carotene [8]

The β-carotene content was extracted by using saturated butanol and fliterate it. The optical density was measured at 440nm.

In-vitro starch digestibility [9]

The *in-vitro* starch digestibility was determined by estimating by maltose quantity released from samples by using 3-5 di-nitrosalicyclic acid method.

Anti-nutritional factors
Total phytate [10]

The total phytate content was determined by extraction of sample with HCl. Pipetted out 0.5ml filtrate and by employing the ammonium ferric sulphate and phytate content was measured at 519 nm using 2,2 bipyridine solution on spectrophotometer.

Oxalates [11]

Hydrochloric acid was used for digesting the food samples and the filtered contents was determined by titrating oxalates containing sulphuric acid against potassium permagnate

Trypsin inhibitor [12]

Trypsin inhibitor was determined by extracting samples in phosphate buffer (0.05M) and incubated at 37˚C for one hour. The tricholoroacetic acid soluble protein in the 0.5 ml of supernatant was determined by the Lowry method. (Lowry *et al* 1951).

Saponin [13]

Saponin content was determined by extraction of samples in 20% aqueous ethanol in water bath for 30 minutes. Extract was transferred in separating funnel with dimethyl ether and shaken well. Diethyl ether layer was discarded and aqueous phase was retained and butanol layer was used for extraction of saponin and extract was dried in hot air oven in pre-evaporating dish. Difference in dish weigh considered the amount of saponin present in sample

Results and Discussion

Physico-chemical analyses of wheat, soybean, oats and pumpkin leaf powder different flours have been discussed in Tables 1-3.

Physical Parameters

The physical parameter of different flours is depicted in **Table 1**. The value for 1000-grain weight of wheat, soybean and oats were significantly ($p<0.05$) different. The soybean grain had higher 1000-grain weight (145.34 g) followed by oats (54.58 g) and wheat (45.1 g). This variation could be due to difference in the grain size. Soliaman *et al* [14] reported that 1000-kernel weight of three varieties of wheat ranged from 45.71-69.125g. The water absorption capacity of wheat, soybean, oats and pumpkin leaf powder was significantly ($p<0.05$) different. The pumpkin leaf powder showed maximum values for water absorption capacity (3.68 g/g) whereas wheat showed minimum values for water absorption capacity (2.31g/g). Oladunmoye *et al* [15] observed that water absorption capacity of cassava and wheat flour to be 221.8g/g and 31.9 g/g. The water solubility index of wheat, soybean, oats and pumpkin leaf powder were significantly ($p<0.05$) different. The soybean had higher water solubility index (12.88±0.33) than pumpkin leaf powder (5.31±0.18) followed by oats (5.23±0.22) and wheat (4.4±0.45) respectively. Adubofuor *et al* [16] reported that water solubility index of wheat flour and composite flour ranged from 3.39±0.64 to 11.54±0.01.

Table 1 Physical parameters of grains (per 100g) on dry matter basis

Treatments	Wheat	Soybean	Oats	Pumpkin leaf powder
Physical Analysis				
Thousand kernel weight	45.1^{c}±0.42	145.34^{a}±6.31	54.58^{b}±0.01	-
Water absorption capacity	2.31^{d}±0.06	2.44^{c}±0.02	2.82^{b}±0.007	3.68^{a}±0.007
Water solubility index	4.4^{c}±0.45	12.88^{a}±0.33	5.23^{b}±0.22	5.31^{b}±0.18

Value are expressed as mean ±SD with different superscripts-a,b,c,d are significantly different ($p<0.05$)

Proximate composition

Moisture

The moisture content was found to be significantly ($p<0.05$) different i.e. grains were in range of 5.69 -7.50 percent and fresh pumpkin leaves contained 82.33 per cent moisture. Longvah *et al* [17] reported the moisture content of wheat, soybean and pumpkin flour to be 11.10, 5.47 and 85.82 percent respectively. Venkateswari and Parameshwari [18] observed that the moisture content of wheat and soy flour were 14 and 4.37 percent. Mebpa *et al* and Saeed *et al* [19, 9] found similar results of moisture content in wheat flour i.e. 11.35 percent. Ndife *et al* [20] reported that the moisture content of wheat and soy flour was 7.00 and 5.50 percent. Rathod [21] observed that the oat flour contained 10.80 percent moisture content whereas Haribhai [22] found 6.68 percent moisture content in oats. This variation is mainly due to varieties of oat samples. The wheat and oat flour were 11.50 and 8.60 percent moisture Chavan [23]. The moisture content of fresh pumpkin leaves was found to be 87.00±0.6 percent Idris [4].

Crude Fat

Among the raw ingredients the crude fat was found to be significantly ($p<0.05$) highest in soybean flour (SF) followed by wheat (WF), oats (OF) and least amount of fat was found in pumpkin leaf powder (PF) i.e. 17.26, 1.26, 1.16 and 0.54 g/100g in SF, WF, OF and PF respectively. The leafy vegetables are lipid lowering foods and prevent non-communicable diseases Idris [4]. Ndife *et al* [20] reported crude fat content to be 10.20 and 3.60 percent in soybean and wheat flour. Chavan [23] analysed that the wheat flour and oat flour contain 1.91 and 8.50 percent of crude fat respectively. Longvah *et al* [17] reported the crude fat content to be 1.53, 19.42, 0.74g/100g in wheat flour, soybean flour and pumpkin leaf powder. Mebpa *et al* and Saeed *et al* [19, 9] found similar results of crude fat content in wheat flour i.e. 1.68.

Crude protein

The crude protein content was found to be significantly ($p<0.05$) highest in soybean i.e. 33.07 percent followed by wheat 8.80 percent than pumpkin leaf powder 3.67 percent and less amount in oats i.e. 3.26 percent respectively. Tariqual *et al* [24] reported crude protein content to be 43.50 per cent in soy flour. Mebpa *et al* [19] found that the wheat flour contained 11.70 per cent crude protein on dry matter basis. Chavan [23] analyzed that the wheat flour and oat flour contain 12.22 and 13.40 percent of crude protein respectively. The oat flour contained 13.75 percent crude protein Rathod [21]. Longvah *et al* [17] reported that wheat flour, soybean flour and pumpkin leaf powder contain 10.57, 37.80 and 4.21 percent crude protein.

Crude ash

The crude ash content was found to be significantly ($p<0.05$) highest in soybean flour i.e. 3.83 percent followed by oats (1.69 percent), pumpkin leaf powder (1.59 percent) and in wheat flour (1.26 percent) respectively. Ogbemudia [25] reported that the higher ash content of soybean flour (4.29 percent) is indicative that the flour sample could be important sources of minerals. The ash content was higher in soybean due to higher molecular weight and their protein content as compared with the other flours. Incorporation of soy flour more Longvah *et al* [17] reported crude ash content to be 1.28, 4.52 and 2.24 percent in wheat, soybean and pumpkin leaf powder. Ndife *et al* [20] found 2.50 and 1.50 percent of ash content in soy flour and wheat flour. Tariqual *et al* [24] reported the ash content to be 2.1 per cent in soy flour. The crude ash content was found to be 0.90 percent in wheat flour Mebpa *et al* [19]. The crude ash content was found to be higher in the leaves of pumpkin because it contains vital mineral element Idris [4]. The crude ash content of wheat flour and oat flour was found to be 1.03 and 2.20 percent Chavan [23]. Rathod [21] reported 1.70 percent crude ash content in oat flour. In the present investigation the value of crude ash content was found to be less or more to the value reported by other researchers.

Crude fibre

The oats flour has significantly ($p<0.05$) highest crude fibre (6.09 percent), followed by soy flour (5.06 percent), 2.12 percent in pumpkin leaf powder and less amount was found to be in wheat flour (3.04 percent). Mebpa *et al* [19] reported that wheat flour contained 0.82 per cent crude fibre. Similar findings of crude fibre were found in soy flour i.e. 5.48 percent Tariqual *et al* [24]. Chavan [23] observed that wheat and oat flour contain 0.30 and 6.90 percent of crude fibre respectively. The crude fibre content was found to be 3.58 percent in oat flour Rathod [21]. Kumar [26] reported the higher amount of fat, protein, ash in oat flour than maize flour.

Carbohydrate and energy

The wheat and oat flour were found to have significantly ($p<0.05$) highest carbohydrate content of 78.41 and 60.69 percent followed by soy flour 56.15 percent and least amount of carbohydrate content was found in pumpkin leaf powder i.e. 9.73 percent. Ndife *et al* [20] found the carbohydrate content to be 35.90 and 69.50 g/100g in soy and wheat flour. Norfezah *et al* [27] found significantly ($p<0.05$) different effect in both drying methods on proximate content of both varieties of pumpkin flour. Venkateswari and Parameshwari [18] reported the carbohydrate content to be 76.0 and 23.05g in whole wheat flour and soy flour. The carbohydrate content of wheat and oat flour was found to be 73.04 and 59.97 percent Chavan [23]. The energy content was significantly ($p<0.05$) higher in soybean (512.25 Kcal) followed by wheat (360.22 Kcal), oats (266.79 Kcal) and pumpkin leaf powder (58.48 Kcal). Haribhai [22] reported that crude protein, fat, ash and carbohydrates of oat flour was found to be 14.62, 8.56, 1.64 and 68.51 percent respectively.

Vitamin and mineral content

Analysis of fresh flours for vitamin, mineral content and *in-vitro* starch digestibility is depicted in **Table 2**. The Vitamin C content was found to be significantly ($p<0.05$) higher in pumpkin (0.51mg) followed by oats and soybean (0.089, 0.081 mg) and less amount was found in 0.07 mg in wheat flour. The β carotene were found to be significantly ($p<0.05$) higher in pumpkin leaf powder (14.69 µg/100g) followed by soy flour (2.70 µg/100g), oats flour (1.20 µg/100g) and least amount of β carotene was found to be (0.96 µg/100g) in wheat flour. Longvah *et al* [17] reported Vitamin C content of pumpkin leaf powder to be 12.33 mg.

Table 2 Nutritional analysis of fresh flours

Nutritional Composition	Wheat	Soybean	Oats	Pumpkin leaf powder
Proximate				
Moisture (g)	$7.22^{c}\pm0.09$	$5.69^{d}\pm0.07$	$7.50^{b}\pm0.04$	$82.33^{a}\pm0.13$
Crude protein (g)	$8.80^{b}\pm0.20$	$33.07^{a}\pm0.63$	$3.26^{c}\pm0.26$	$3.67^{c}\pm0.17$
Crude fat (g)	$1.26^{b}\pm0.02$	$17.26^{a}\pm0.11$	$1.16^{b}\pm0.18$	$0.54^{c}\pm0.02$
Crude ash (g)	$1.26^{c}\pm0.02$	$3.83^{a}\pm0.07$	$1.69^{b}\pm0.09$	$1.59^{b}\pm0.05$
Crude fibre (g)	$3.04^{c}\pm0.20$	$5.06^{b}\pm0.16$	$6.09^{a}\pm0.19$	$2.12^{d}\pm0.05$
Carbohydrate (g)	$78.41^{a}\pm0.31$	$56.15^{c}\pm0.49$	$60.69^{b}\pm0.14$	$9.73^{d}\pm0.06$
Energy (Kcal)	$360.22^{b}\pm0.99$	$512.25^{a}\pm1.19$	$266.79^{c}\pm1.61$	$58.48^{d}\pm0.77$
Vitamin content				
β- carotene (µg)	$0.96^{d}\pm0.023$	$2.70^{b}\pm0.01$	$1.20^{c}\pm0.01$	$14.69^{a}\pm0.02$
Vitamin C (mg)	$0.07^{c}\pm0.02$	$0.081^{ab}\pm0.01$	$0.089^{b}\pm0.01$	$0.51^{a}\pm0.004$
Mineral content				
Calcium (mg)	$47.14^{d}\pm1.68$	$186.04^{b}\pm0.40$	$56.37^{c}\pm0.93$	$289.68^{a}\pm0.11$
Iron (mg)	$5.24^{b}\pm0.01$	$8.71^{a}\pm0.001$	$3.76^{d}\pm0.01$	$4.1^{c}\pm0.001$
***In-vitro* digestibility**				
Starch digestibility (%)	$0.34^{b}\pm0.001$	$0.59^{a}\pm0.004$	$0.08^{d}\pm0.003$	$0.09^{c}\pm0.0009$

Values are expressed as mean ± SD with different superscripts –a, b, c, d are significantly different ($p<0.05$)

The mineral content such as calcium was found to be significantly ($p<0.05$) higher in pumpkin leaf powder (289.68 mg) followed by soybean (186.04 mg), oats (56.37 mg) and less amount in wheat i.e. 47.14 mg. Haribhai [22] observed that calcium content of oat flour to be 83.86 mg/100g. Longvah *et al* [17] reported calcium content to be 30.94 mg, 195 mg and 271 mg in wheat flour, soy flour and pumpkin leaf powder. In present study, the iron content was found to be highest in soybean (8.71 mg) followed by wheat (5.24 mg), pumpkin leaf powder (4.1 mg) and less amount of iron content i.e. 3.76 mg in oats flour. Idris [4] reported that potassium, magnesium, copper and iron content was found to be higher in pumpkin leaves whereas poor source of phosphorus and sodium. Kumar [26] reported zinc and iron content to be 0.90-2.71 mg/100g and 2.6-7.9 mg/100g in flour.

In-vitro starch digestibility has been presented in Table 2. *In-vitro* starch digestibility of various blends of flour was found to be significantly ($p<0.05$) higher 0.59% in soy flour followed by wheat flour (0.34), pumpkin leaf powder (0.09%) and minimum amount 0.08% found in oats respectively.

Anti-nutritional Factors

The anti-nutritional factors of raw ingredients i.e. phytate, total phenol, oxalate, trypsin and saponin has been represented in **Table 3**. The phytate content was found to be significantly ($p<0.05$) higher in oats flour (20.93 mg) followed by wheat flour (16.32 mg), soy flour (11.04 mg) and least amount of phytate was found (0.30 mg) in pumpkin leaf powder. Kumar [26] reported that oat flour contained 62.03-103 mg phytic acid content. Bolarinwa *et al* [28] observed that total phytate content to be 39.4 mg and 22.7 mg in composite flour and wheat flour. The oxalate content was found to significantly ($p<0.05$) higher in soy flour (5.40 mg) followed by wheat flour (2.83 mg), oat flour (2.33 mg) and very less amount of oxalate content was found i.e. (0.81 mg) in pumpkin leaf powder. In soy flour the anti-nutritional factor i.e. saponin was found to be significantly ($p<0.05$) higher in soybean i.e. 4.26 mg followed by wheat flour (0.94 percent) and least amount was found to be 0.08 and 0.02 percent in oat flour and pumpkin leaf powder. The trypsin content was found to be significantly ($p<0.05$) higher in oat flour i.e. 1.81 TIU/mg followed by wheat flour (1.50 TIU/mg), soy flour (1.13 TIU/mg) and least amount of trypsin content was analysed i.e. 0.17 TIU/mg in pumpkin leaf powder.

Table 3 Anti-nutritional factors of samples (on dry matter basis)

Anti-nutritional factors	Wheat	Soybean	Oats	Pumpkin leaves
Phytic acid(mg)	$16.32^{b}\pm0.21$	$11.04^{c}\pm0.05$	$20.93^{a}\pm0.25$	$0.30^{d}\pm0.004$
Oxalates (mg)	$2.83^{b}\pm0.04$	$5.40^{a}\pm0.38$	$2.33^{c}\pm0.22$	$0.81^{d}\pm0.005$
Saponin (%)	$0.94^{b}\pm0.08$	$4.26^{a}\pm0.25$	$0.08^{c}\pm0.003$	$0.025^{c}\pm0.004$
Trypsin TIU/mg	$1.50^{b}\pm0.018$	$1.13^{c}\pm0.01$	$1.81^{a}\pm0.01$	$0.17^{d}\pm0.0001$

Values are expressed as mean ± SD with different superscripts –a, b, c, d are significantly different ($p<0.05$)

Conclusion

The quality and properties of the flours were evaluated through this study using different parameters. It was concluded that blending of these flours and powder can be a good choice to overcome malnutrition in India. These blended flours (wheat, soybean, oats and pumpkin leaves powder) are highly enriched with various nutrients like protein, fats, carbohydrates, dietary fibre, antioxidants, vitamins and minerals which not only improve the nutritional status of the population but also help those who were suffering from various degenerative diseases associated with the change in their life styles and environment. The flour has good protein contents and could be used to fortify flours with low protein content such as wheat and oats. The food value of these flours and their blends can also be pre-determined to provide value-added food for consumers. The blends of these flours can also utilize in the bakery industry as novel ingredients so as to improve the wholesomeness of the food products.

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